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Begin Translation:

CLAIMS

[Claim(s)]
[Claim 1] The coil unit used for the linear motor which equipped this crevice with the shell which can cool this coil through the refrigerant while leaving a predetermined crevice and holding the coil by which opposite arrangement is carried out at the magnet of a linear motor characterized by providing the following, and this coil in the interior. While leaving a predetermined crevice and holding the aforementioned shell in the interior, it lets a refrigerant pass in this crevice, and it is outside covering which can cool this shell. While introducing in self the aforementioned refrigerant which is prolonged and formed in a longitudinal direction near the crosswise end edge of the aforementioned shell in this outside covering, and is supplied from the outside, it is the 1st mainstream way of an outside which can be derived crosswise to the outside surface of this shell about this refrigerant. While receiving the aforementioned refrigerant which was prolonged and formed in the longitudinal direction near the crosswise other end edge of the aforementioned shell in the aforementioned outside covering, and has flowed the outside surface of the aforementioned shell crosswise through the aforementioned 1st mainstream way of an outside, it is the 2nd mainstream way of an outside which can be supplied in this shell about this refrigerant. It is the exhaust pipe which can be discharged outside about the aforementioned refrigerant which has flowed the coil front face in shell.
[Claim 2] the [set to a claim 1 and further aforementioned / in the aforementioned shell / outside] -- it prolongs and forms in 2 mainstream road side at a longitudinal direction -- having -- the [this / outside] -- the coil unit for linear motors characterized by equipping the front face of the coil in the aforementioned shell with the inside mainstream way which can be derived crosswise for this refrigerant while introducing in self the aforementioned refrigerant supplied from 2 mainstream ways
[Claim 3] The coil unit for linear motors characterized by having the 2nd mainstream way of the inside which can discharge this refrigerant from the aforementioned exhaust pipe while receiving the aforementioned refrigerant which set to a claim 1 or 2, was further prolonged and formed in the aforementioned 1st mainstream road side of an outside in the aforementioned shell at the longitudinal direction, and has flowed this coil front face in the aforementioned shell crosswise.
[Claim 4] In claims 1 and 2 or 3, while forming in the longitudinal direction end close-attendants side of the aforementioned outside covering the feed holes which can supply the aforementioned refrigerant to the aforementioned 1st mainstream way of an outside The run

through-hole which can be supplied in the aforementioned shell is formed for the aforementioned refrigerant guided into self at the longitudinal direction other end close-attendants side of the aforementioned 2nd mainstream way of an outside. And the coil unit for linear motors characterized by having arranged the aforementioned exhaust pipe which can discharge the aforementioned refrigerant in the aforementioned equivalent position near the feed holes in this shell.
[Claim 5] The coil unit for linear motors characterized by arranging it in a claim 4 as the aforementioned exhaust pipe penetrates near the downstream of the aforementioned feed holes in the aforementioned 1st mainstream way of an outside.
[Claim 6] a claim 1 or either of 5 -- setting -- the [aforementioned / outside] -- the branch passage of plurality [way / mainstream / 1] -- a longitudinal direction predetermined interval -- forming -- the / this / outside / -- the coil unit for linear motors which the aforementioned refrigerant introduced in 1 mainstream way is branched by each of two or more of these branch passage, and is characterized by enabling derivation crosswise at the outside surface of the aforementioned shell
[Claim 7] The coil unit for linear motors characterized by having formed the subpassage of the longitudinal direction which can once be stored in the claim 6 for the aforementioned refrigerant drawn from this branch passage by the down-stream edge of the aforementioned branch passage, and enabling derivation crosswise of this refrigerant through this subpassage at the outside surface of the aforementioned shell.
[Claim 8] The coil unit used for the linear motor which equipped this crevice with the shell which can cool this coil through the refrigerant while leaving a predetermined crevice and holding the coil by which opposite arrangement is carried out at the magnet of a linear motor characterized by providing the following, and this coil in the interior. While leaving a predetermined crevice and holding the aforementioned shell in the interior, it lets a refrigerant pass in this crevice, and it is outside covering which can cool this shell. While introducing in self the aforementioned refrigerant which is prolonged and formed in a longitudinal direction near the crosswise end edge of the aforementioned coil in the aforementioned shell, and is supplied from the outside, it is the 1st guidance way which can be derived crosswise on the front face of the aforementioned coil about this refrigerant. While receiving the aforementioned refrigerant which was prolonged and formed in the longitudinal direction near the crosswise other end edge of the aforementioned coil in the aforementioned shell, and has flowed the front face of this coil crosswise through the aforementioned 1st guidance way, it is the 2nd guidance way which can be supplied to the aforementioned crevice between this shell and the aforementioned outside covering about this refrigerant. It is the discharge hole which can be discharged outside about the aforementioned refrigerant which has flowed the outside surface of the aforementioned shell.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the technology which cools a coil with a refrigerant especially about the coil unit equipped with the coil by which opposite arrangement is carried out at the magnet in a linear motor, and the shell which holds this coil in the interior and cools this coil through a refrigerant in the crevice between selves for linear motors.
[0002]

[Description of the Prior Art] an aligner, a high precision finishing machine, etc. for the conventional, for example, semiconductor, manufacture -- setting -- an object (for example, the wafer and workpiece which are exposed) -- high degree of accuracy -- and to position quickly is demanded In this case, as a precision pointing device used, what changes rotation of a rotated type motor into rectilinear motion by the ball thread etc., the rectilinear-motion type motor (the so-called linear motor), etc. are used widely.

[0003] Also in this, structure of a linear motor is brief, part mark end few, and have the merit that the direct use of the rectilinear motion can be carried out further, and it can position an object quickly. Moreover, since there is little frictional resistance at the time of a drive, it also has the feature that a precision of operation can be raised. It is becoming in use [the above reason to a linear motor] as a straight-line driving gear of all fields with which precise positioning is demanded, for example, the manufacturing process of a liquid crystal display is also used widely.

[0004] Generally this linear motor consists of a magnetic pole unit equipped with the magnet, and a coil unit equipped with the coil. A magnetic pole unit or a coil unit is connected with a predetermined pedestal, it functions as a stator, and another side is connected with a move table etc. and functions as a needle. The fixed crevice is left so that it may not contact mutually, and where the crevice is maintained, rectilinear motion of this magnetic pole unit and the coil unit is carried out relatively.

[0005] By the way, the coil prepared in the above-mentioned coil unit will generate heat, if current is supplied. This generation of heat is transmitted to the whole coil unit, and is further transmitted to a pedestal, a move table, etc. which have been combined with this coil unit. Consequently, two problems as shown below occur.

[0006] (1) It becomes the factor which the coil unit itself and the other party machine connected with this coil unit expand thermally [factor], and makes positioning accuracy produce an error with the heat of a coil. Specifically, if the other party machine connected with a coil unit was low-fever expansion material (coefficient of thermal expansion 1x10-6) with a length of 100mm, 100nm heat deformation arises by the 1-degree C temperature rise. Therefore, when the positioning accuracy of nano meter order is required, this thermal expansion cannot become a cause and a demand cannot fully be filled.

[0007] (2) Near the linear motor, the laser interferometer which measures movement of this linear motor is installed. If a surrounding atmosphere is heated by the coil unit and "fluctuation" occurs by it, the optical path of a laser beam will be affected and a measurement error will arise.

[0008] Here, a refrigerant is poured between the clamp face of the other party machine in a coil unit, and a coil as what solves the problem of (1), and the technology of preventing transfer of the heat from a coil is known. However, in this technology, the temperature rise of the atmosphere around a coil unit could not be suppressed, and the trouble of (2) was not solved after all.

[0009] Then, the coil unit 10 as shown in drawing 10 and drawing 11 is proposed as what solves the problem of the both sides of (1) and (2) collectively. This coil unit 10 is used for a linear motor 1, and opposite arrangement is carried out at the magnet 3 of the magnet unit 2.

[0010] Concretely, this coil unit 10 equips a magnet 3 with the shell 14 which can cool a coil 12 through a refrigerant in the crevice 13 between a coil 12 and self while holding the plate-like long coil 12 and this coil 12 in the interior at the travelling direction X by which opposite arrangement is carried out. On the other hand, the magnet unit 2 is equipped with the cross-section KO character-like base 4, and the above-mentioned magnets 3 and 3 are attached in wall 4A countered in this base 4.

[0011] The clamp face 16 to the other party machine is formed in the outside of one edge

14A of the cross direction Y in shell 14, the feed holes 18 which supply a refrigerant to the crevice 13 between shell 14 are formed in the end side of the longitudinal direction X of this clamp face 16, and the discharge hole 20 which discharges this refrigerant is formed in the other end side. When the coil unit 10 is connected with a "fixed side" other party machine through this clamp face 16, the coil unit 10 serves as a stator and the magnet unit 2 serves as a needle. On the contrary, when the coil unit 10 is connected with a "movement side" partner machine, the coil unit 10 serves as a needle and the magnet unit 2 serves as a stator.

[0012] The refrigerant supplied from feed holes 18 is diffused in the crevice 13 between a coil 12 and shell 14, and delivers and receives heat between coils 12. Therefore, the coil 12 which generates heat by current is cooled, and a refrigerant is heated. Since the heated refrigerant is discharged from a discharge hole 20, heat is not accumulated inside the coil unit 10, but the radiation to a surrounding atmosphere is reduced. Therefore, this linear motor 1 can lessen influence on the exterior by generation of heat of a coil 12, and highly precise positioning is possible for it.

[0013]

[Problem(s) to be Solved by the Invention] However, in such a coil unit 10, it was not necessarily able to be said that sufficient cooling effect was acquired. if the diffusion situation of the refrigerant in shell 14 is concretely shown in drawing 12 typically -- a refrigerant -- A, B, and C -- it becomes ... with a parallel flow with a breadth gradually, and it is discharged from a discharge hole 20, converging with F, G, and H finally Since a refrigerant is heated as it moves to a downstream, as mostly in agreement with the order of this A and B, C...E, and G and H, temperature will rise.

[0014] The temperature of the refrigerant in this result, especially the downstream (E, G, H) neighborhood was rising sharply as compared with the upstream, and it had the problem that heat transmitted to shell 14 through the refrigerant of this elevated-temperature state, and it was radiated outside while cooling efficiency fell. Furthermore, heat transmitted to the clamp face 16 through the refrigerant of the elevated-temperature state of a downstream, and it had also become the cause which induces the thermal expansion by the side of a partner machine.

[0015] And this property is generated unescapable, even if the pressure (supply pressure) of a refrigerant and the size of a crevice are designed comparatively good. Moreover, when a design was not good, it is the situation which the portion into which a refrigerant hardly flows tends to produce, and there was fault also with a bird clapper much more notably.

[0016] Although the flow rate of a refrigerant was increased and cooling efficiency needed to be raised in order to solve these, when the large crevice 13 was taken for flow rate increase, the magnet 3 by the side of the magnet unit 2 and the distance S between three (refer to drawing 1) became large, flux density became small, and there was a problem that the driving force of a linear motor 1 decreased. Moreover, when the flow rate of a refrigerant was increased, thickness of shell 14 needed to be thickened, pressure resistance needed to be raised, and this thick increase also affected the fall of the driving force (thrust) of a linear motor 1.

[0017] On the other hand, the demand of wanting to suppress the temperature rise of a linear motor on still higher level is increasing with the advancement of a manufacture process in recent years. However, there is a limitation in the refrigeration capacity of the coil 12 in the coil unit 10, and the present condition is that it cannot be satisfied [with the situation that fixed restrictions are imposed on the thickness of shell 14, the size of a crevice 13, etc.] of the above-mentioned demand.

[0018] this invention is made in view of the trouble relevant to uneven cooling and the shortage of refrigeration capacity of the coil by the refrigerant as shown above, and aims at

reducing the temperature rise of a coil unit by leaps and bounds than before according to the new cooling structure using the refrigerant.
[0019]
[Means for Solving the Problem] While this invention leaves a predetermined crevice and holds the coil by which opposite arrangement is carried out at the magnet of a linear motor, and this coil in the interior While leaving a predetermined crevice and holding shell in the interior in the coil unit used for the linear motor which equipped this crevice with the shell which can cool this coil through the refrigerant While introducing in self the refrigerant which is prolonged and formed in this crevice through a refrigerant at a longitudinal direction near the crosswise end edge of the shell in outside covering which can cool shell, and this outside covering, and is supplied from the outside While receiving the refrigerant which was prolonged and formed in the outside surface of shell in this refrigerant at the longitudinal direction the 1st mainstream way of an outside which can be derived crosswise, and near the crosswise other end edge of the shell in outside covering, and has flowed the outside surface of shell crosswise through the 1st mainstream way of an outside The above-mentioned purpose is attained by having the exhaust pipe which can be discharged outside for the refrigerant which has flowed the 2nd mainstream way of an outside which can be supplied in shell, and the coil front face in shell in this refrigerant.
[0020] In this coil unit, the double cooling structure by arranging outside covering in the circumference of shell further was adopted. Moreover, further, it is shown to a refrigerant by the 1st mainstream way of an outside at the longitudinal direction of a coil (low-temperature state), and first has the structure where a refrigerant (turning to an other end side from an end side) flows the crevice between shell and outside covering crosswise through this 1st mainstream way of an outside, by it. this refrigerant -- the [outside] -- pass 2 mainstream ways -- the interior of shell is supplied -- having -- a coil front face -- the cross direction -- (-- it flows from an other end side to) towards an end side, and is discharged from an exhaust pipe (in the state where it became an elevated temperature most)
[0021] therefore, the thing for which equalization of cooling is attained by the longitudinal direction -- in addition, since it is the structure which cools a coil front face and a shell outside surface by the so-called countercurrent flow, crosswise equalization is also attained, the whole coil unit is covered, and temperature tends to become uniform, and cooling efficiency is also raised more sharply than before Consequently, the local temperature rise of a surrounding atmosphere is prevented.
[0022] moreover, it was supplied in outside covering -- with the refrigerant of a low-temperature state, just before being discharged in shell, the refrigerant of an elevated-temperature state is covered most Moreover, near the crosswise middle, the refrigerant which flows the inside of outside covering and which changed into the elevated-temperature state moderately (cooling a coil) in shell is moderately covered with the refrigerant of a low-temperature state. Thus, since heat transfer of a coil is suppressed outside by existence of the refrigerant in outside covering very rationally from inside, the temperature rise of a coil unit can be reduced by it more sharply than before.
[0023] In addition, it sets to the above-mentioned invention, and while introducing in self the aforementioned refrigerant supplied from the 2nd mainstream way of an outside, you may make it to be prolonged and formed in the 2nd mainstream road side of an outside in shell at a longitudinal direction, and equip the front face of the coil in the aforementioned shell with the inside mainstream way which can be derived crosswise for a refrigerant further.
[0024] Since according to this structure it is drawn by the coil front face after a refrigerant is again introduced into a longitudinal direction by the inside mainstream way even if it is

the case (confused) where the flow of a refrigerant becomes uneven by having flowed to the 2nd mainstream way of an outside, uniform cooling of a coil is attained.
[0025] It is prolonged and formed in the 1st mainstream road side of an outside in shell at a longitudinal direction, and while receiving the refrigerant which has flowed the coil front face in shell crosswise, you may make it have further the 2nd mainstream way of the inside which can discharge this refrigerant from an exhaust pipe in the above-mentioned invention.
[0026] The refrigerant which became an elevated temperature by cooling a coil must be discharged outside as promptly as possible, and must suppress the influence of the heat to the circumference. Then, since according to this structure the refrigerant of an elevated-temperature state is promptly discharged first by the 2nd mainstream way of the inside and is not overdue to the circumference of a coil, the local elevated-temperature state on a coil is prevented.
[0027] Furthermore, since the 2nd mainstream way of the inside of a longitudinal direction where this refrigerant (elevated-temperature state) is introduced can be covered by the 1st mainstream way of an outside of a longitudinal direction where the refrigerant of a low-temperature state is introduced most, heat transfer to circumference atmosphere or a machine clamp face is suppressed. In addition, the machine clamp face which attaches this coil unit in the other party machine has the desirable 1st mainstream road side of an outside in the periphery of outside covering so that clearly from the above-mentioned content. This is because heat transfer from a coil is intercepted by this 1st mainstream way of an outside.
[0028] Moreover, in the above-mentioned invention, while forming in the longitudinal direction end close-attendants side of outside covering the feed holes which can supply a refrigerant to the 1st mainstream way of an outside It is desirable to arrange the exhaust pipe which can form the run through-hole which can be supplied in shell for the refrigerant guided into self at the longitudinal direction other end close-attendants side of the 2nd mainstream way of an outside, and can discharge the refrigerant in this shell in the aforementioned equivalent position near the feed holes in shell.
[0029] thus -- if it carries out -- a feed-holes -> free passage -- a hole -- since a refrigerant moves in order of -> exhaust pipe, if it ******, a refrigerant will be supplied from feed holes, and it will move in the diagonal line top of a coil unit, and will become the cooling structure which returns to near the feed holes again and is discharged from an exhaust pipe Therefore, the whole coil can be covered, the still more uniform cooling effect can be acquired, and suppression becomes possible on still higher level about the temperature rise of a surrounding atmosphere. Moreover, since a supply and eccrisis side approaches, an external piping design becomes easy.
[0030] Furthermore, if it is desirable to arrange near the downstream of feed holes [in / the 1st mainstream way of an outside / for the above-mentioned exhaust pipe] as it penetrates and it does in this way The heat which a coil generates after only the refrigerant in an exhaust pipe has got warm is recoverable, suppressing the local temperature rise of the coil unit near the exhaust pipe, since the peripheral face of the exhaust pipe which the refrigerant of an elevated-temperature state passes most is cooled with the refrigerant which flows the 1st mainstream way of an outside. In addition, it is located in the longitudinal direction inside near the downstream of feed holes rather than feed holes, and they are being close to these feed holes, and abbreviation homonymy.
[0031] the [moreover, / in all the above-mentioned invention / outside] -- as a means by which 1 mainstream way derives a refrigerant crosswise to the outside surface of shell -- the [for example, / outside] -- the branch passage of plurality [way / mainstream / 1] -- a longitudinal direction predetermined interval -- forming -- the / this / outside / -- it is desirable to branch the refrigerant introduced in 1 mainstream way by each of two or more

of these branch passage, and to enable derivation crosswise of it at the outside surface of In addition, the number of these branch passage, a configuration, length, etc. are not limited at all, and, in short, just derive a refrigerant crosswise.
[0032] Furthermore, it is desirable to form in the down-stream edge of this branch passage the subpassage of the longitudinal direction which can once be stored for the aforementioned refrigerant drawn from this branch passage, and to enable derivation of this refrigerant through subpassage at the outside surface of the aforementioned shell. Since according to this structure it is drawn by the outside surface of shell while the refrigerant drawn from each branch passage is spread in a longitudinal direction by subpassage and a pressure and a flow rate are equalized by the longitudinal direction, the homogeneity of the temperature distribution of the peripheral face of a coil unit can be raised. Moreover, by branch passage, since the pressure of a refrigerant [in / the 1st mainstream way / by 1 or subpassage] is spread in a longitudinal direction and flows in crosswise, though it is also possible to make thickness of outside covering or shell thin and it is made into double cooling structure, a coil unit can be constituted comparatively compactly.
[0033] By the way, it is one side, and if a refrigerant is poured to opposite direction, it comes to be able to do usage which raised the "thermolysis nature" of a coil unit more, although it sets it as the main purposes that the above thought suppresses the thermal effect which a coil unit has on a surrounding atmosphere and a surrounding partner machine.
[0034] While leaving a predetermined crevice and specifically holding the coil by which opposite arrangement is carried out at the magnet of a linear motor, and a coil in the interior While leaving a predetermined crevice and holding shell in the interior in the coil unit used for the linear motor which equipped the crevice with the shell which can cool this coil through the refrigerant Through a refrigerant, near the crosswise end edge of outside covering which can cool this shell, and the coil in shell, it is prolonged in a longitudinal direction and formed at it between these. While introducing in self the refrigerant supplied from the outside, this refrigerant The 1st guidance way which can be derived crosswise on the surface of a coil, While receiving the refrigerant which was prolonged and formed in the longitudinal direction near the crosswise other end edge of the coil in shell, and has flowed the front face of a coil crosswise through the 1st guidance way What is necessary is just to have the discharge hole which can be discharged outside for the refrigerant which has flowed the 2nd guidance way which can be supplied to the crevice between shell and outside covering, and the shell outside surface in this refrigerant.
[0035] In short, this invention considers conversely the flow (the upstream, lower stream of a river) of the refrigerant of structure explained so far.
[0036] If it does in this way, the heat of a refrigerant will be emitted outside because the refrigerant of a low-temperature state cools a coil front face first and flows the crevice between shell and outside covering after that. Therefore, since a coil can be cooled positively, it is suitable when the temperature rise of a coil itself needs to be especially reduced as much as possible in a mass linear motor (suppression of the temperature rise of a surrounding atmosphere). In addition, what is necessary is just to apply reversely all the things that also showed still more detailed structure above.
[0037]
[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained in detail, referring to a drawing.
[0038] The coil unit 32 used for the linear motor 30 concerning the 1st operation gestalt is shown in drawing 1 and drawing 2 .
[0039] While the coil unit 32 leaves the predetermined crevice 42 and holds the plate-like coil 40 long to the travelling direction X (refer to drawing 2) by which opposite arrangement is carried out at the magnets 36 and 36 of the magnet unit 34, and this coil 40

in the interior While breaking predetermined crevice 42B in this crevice 42 and holding in it the shell 44 which can cool a coil 40, and this shell 44 in the interior through a refrigerant, this crevice 42B is equipped with the outside covering 64 which can cool shell 44 through a refrigerant. In addition, this magnet unit 34 is equipped with the cross-section KO character-like base 38, and is the structure where the above-mentioned magnets 36 and 36 were attached in wall 38A of this base 38.

[0040] The cross section perpendicular to travelling direction X has become I character-like (saddle type), and more specifically, the piece 46 of a coil shown in drawing 3 combines two or more plate-like coils 40, they are carried out, and are constituted. Although this piece 46 of a coil coils copper wire in the shape of a ring, it is orthopedically operated as a whole so that the ends of bay 46A and this bay 46A may be equipped with flection 46B by which incurvation formation is carried out (exterior). Therefore, as shown in drawing 4 , two or more pieces 46 of a coil are combined by turns so that bay 46A may overlap, and the above-mentioned I character-like coil 40 is constituted for U layers of V layers of W layers of ..., then cross sections in order of travelling direction X. In the state with this, since it is not connected mutually but decomposes, as shown in drawing 2 , the mould of this coil 40 is really carried out with Resin G with the coil electrode holder 48 of the longitudinal direction arranged at the crosswise Y end marginal 40A side.

[0041] Shell 44 is a member which holds a coil 40 in the interior, and is equipped with the plate 50 made from stainless steel connected with the above-mentioned coil electrode holder 48 and this above-mentioned coil electrode holder 48. As a plate 50 meets in the shape of [of a coil 40] a cross section of I characters, it is crooked, and where a coil 40 is held in the interior, the predetermined crevice 42 is formed in bay 46A of this coil 40.

[0042] The outside covering 64 is a member which holds shell 44 in the interior, equips the travelling direction X attached in crosswise Y outside of the coil electrode holder 48 with the long outer cover 66 and the outside plate 68 made from stainless steel connected with this outer cover 66, and is constituted. As the outside plate 68 meets the plate 50 of shell 44, it is crooked on it, and where shell 44 is held in the interior, predetermined crevice 42B is formed (in bay 46A considerable position of a coil 40).

[0043] Next, with reference to drawing 1 and drawing 5 - drawing 7 , the cooling structure of the coil 40 in the coil unit 32 is explained in detail.

[0044] As shown in drawing 5 and drawing 6 , near the crosswise end marginal 44A of the shell 44 in the outside covering 64, the 1st mainstream way 70 of an outside prolonged in a longitudinal direction (it is the same as travelling direction) X is formed. The feed holes 72 which can supply a refrigerant to this 1st mainstream way 70 of an outside are formed in the longitudinal direction end 70A close-attendants side of this 1st mainstream way 70 of an outside, and the refrigerant supplied from these feed holes 72 is guided by the 1st mainstream way 70 of an outside at a longitudinal direction X.

[0045] Two or more branch passage 74 is formed in this 1st mainstream way 70 of an outside at intervals of longitudinal direction X predetermined. The refrigerant introduced by this branch passage 74 in the 1st mainstream way 70 of an outside branches, and the outside surface (crevice 42B) of shell 44 is flowed crosswise [Y].

[0046] The 2nd mainstream way 76 of an outside prolonged in a longitudinal direction X is formed in the crosswise other end marginal 44B close-attendants side of the shell 44 in the outside covering 64. the [this / outside] -- the 2 mainstream passage 76 -- the [outside] -- pass 1 mainstream way 70 and the branch passage 74 -- while receiving the refrigerant which has flowed outside-surface 44C (crevice 42B) of shell 44 crosswise [Y], this refrigerant is supplied to the interior of shell 44 In addition, this 2nd mainstream way 76 of an outside is formed by extending the crevice between a plate 50 and the outside plate 68 (crevice 42B near the bay 40A of a coil 40).

[0047] The subpassage 78 of the longitudinal direction X which can once be stored is formed in down-stream edge 74A (refer to drawing 1) of the above-mentioned branch passage 74 in the refrigerant drawn from here. This subpassage 78 has structure which derives this refrigerant to crevice 42B while storing a refrigerant, and it has the so-called role like a buffer. In addition, this subpassage 78 is formed by extending the crevice between a plate 50 and the outside plate 68 rather than the above-mentioned crevice 42B.
[0048] In addition, the above-mentioned 1st mainstream way 70 of an outside and the branch passage 74 form a slot in the wall of an outer cover 66 by cutting etc., and should just consist of aforementioned slots in the state where this outer cover 66 was attached in the coil electrode holder 48.
[0049] Next, the cooling structure inside shell 44 is explained.
[0050] As shown in drawing 5 , the inside mainstream way 56 prolonged in the 2nd mainstream way 76 side of an outside at a longitudinal direction X is formed in the interior of shell 44. That is, the 2nd mainstream way 76 of an outside and the inside mainstream way 56 are arranged in parallel. the [this / outside] -- the free passage which connects these with longitudinal direction X other end side of 2 mainstream way 76 and inside mainstream way 56 56B (namely, the feed holes 72 and the opposite side in a longitudinal direction X) -- a hole 78 forms -- having -- **** -- this free passage -- a hole 78 -- minding -- the [outside] -- the refrigerant guided in 2 mainstream ways 76 is supplied to the inside mainstream way 56 in addition, passage formation of the longitudinal direction X by which this inside mainstream way 56 has been arranged in shell 44 -- it is constituted by forming a slot in a member 57
[0051] Two or more ramus-medialis passage 56A at a predetermined interval is formed in this inside mainstream way 56 at the longitudinal direction X, and the refrigerant guided in the inside of the inside mainstream way 56 at the longitudinal direction X is drawn crosswise [Y] by the front face of a coil 40 through this ramus-medialis passage 56A (in crevice 42). In detail, this branch passage 56A is formed in the three directions for every predetermined interval, respectively (refer to drawing 1), and the refrigerant drawn from each flows to the crevice 42 side.
[0052] As shown in drawing 7 , the 2nd mainstream way 52 of the inside which receives the refrigerant which has flowed the front face of a coil 40 crosswise [Y] is formed in the 1st mainstream way 70 side of an outside in shell 44. Pore 54 is formed in this 2nd mainstream way 52 of the inside at intervals of longitudinal direction X predetermined (refer to drawing 1), and the refrigerant which has flowed the front face of a coil 40 flows into the 2nd mainstream way 52 of the inside through two or more pores 54. Furthermore, the exhaust pipe 55 which can discharge the refrigerant collected by this 2nd mainstream way 52 of the inside is formed in the end 52A side of the longitudinal direction X in this 2nd mainstream way 52 of the inside. More specifically, the above-mentioned exhaust pipe 55 penetrates and opening of near the downstream of the feed holes 72 in the 1st mainstream way 70 of an outside is carried out to an outer cover 66 side. That is, the 1st mainstream way 70 of an outside encloses the circumference of an exhaust pipe 55 (refer to drawing 6).
[0053] In addition, what is necessary is just to form the 2nd mainstream way 52 of the inside, and the pore 54 grade in the coil electrode holder 48 before really carrying out the mould of the coil 40 by cutting etc.
[0054] Next, an operation of this coil unit 32 is explained.
[0055] The refrigerant supplied from feed holes 72 is guided by the 1st mainstream way 70 of an outside at a longitudinal direction X. If the pressure of this 1st mainstream way 70 of an outside increases, a refrigerant will flow into the subpassage 78 through the branch passage 74. Since the amount of refrigerants introduced into the subpassage 78 is already

considerably equalized by the function of the 1st mainstream way 70 of an outside in the longitudinal direction X from each branch passage 74, the pressure of the refrigerant in the subpassage 78 is further equalized in the longitudinal direction X. And the refrigerant in this subpassage 78 flows into crevice 42B crosswise [Y].

[0056] The refrigerant which cooled outside-surface 44C of shell 44 through this crevice 42B flows into the 2nd mainstream way 76 of an outside, and is guided at a longitudinal direction X. This refrigerant is supplied to the inside mainstream way 56 from the run through-hole 78, and is guided at the above-mentioned guidance direction and above-mentioned opposite direction of the 2nd mainstream way 76 of an outside. If the pressure of the refrigerant in this inside mainstream way 56 increases, this refrigerant flows out of ramus-medialis passage 56A, and fills the interior of shell 44. The refrigerant which flowed along the cross direction Y and cooled the coil 40 flows in in the 2nd mainstream way 52 of the inside through pore 54. The refrigerant which flowed in in this 2nd mainstream way 52 of the inside is guided at a longitudinal direction X, and is discharged from an exhaust pipe 55.

[0057] According to this coil unit 32, it has wrap dual structure with shell 44 and the outside covering 64 in the coil 40. Furthermore, while a refrigerant is guided by the 1st mainstream way 70 of an outside, and the inside mainstream way 56 at a longitudinal direction X (diffusion), it is the structure which flows out crosswise [Y] after that. Therefore, in each crevices 42 and 42B, the countercurrent flow of the cross direction Y is formed relatively.

[0058] Since uniform cooling is attained in both directions of a longitudinal direction X and the cross direction Y by diffusion of the longitudinal direction X of these refrigerants, and crosswise Y countercurrent flow, the whole coil unit 32 can be covered and temperature can be made uniform by them. Consequently, even if it does not increase the flow rate of a refrigerant, as compared with the former, cooling efficiency can be raised sharply.

[0059] For example, according to the analysis result by this invention person, when the flow rate of 200 (W) and a refrigerant is temporarily set to 2 (l/min) for the calorific value of a coil, the temperature of the outside surface of the conventional coil unit is stopped by about 0.45-degree C temperature rise in the coil unit 32 of a **** 1 operation gestalt to going up by about 2.5 degrees C. In addition, although the above-mentioned analysis result changes with the quality of the material of shell, or kinds of refrigerant, the result which was extremely excellent in the case of which can be obtained.

[0060] Especially the refrigerant that flows crevice 42B of the outside covering 64 and shell 44 intercepts effectively the influence of heat transfer to the exterior of a coil 40, and has wrap structure with the refrigerant of a low-temperature state most in the portion of shell 44 which serves as an elevated temperature most. That is, since the low-temperature refrigerant which just flowed to outside crevice 42B will cover the hot refrigerant in front of the recovery in shell 44, in addition to improvement in the cooling efficiency of a coil 40, it can reduce sharply the amount of heat transfer to external atmosphere.

[0061] Moreover, since it is collected by the 2nd mainstream way 76 of an outside and the inside mainstream way 56 shows around again at a longitudinal direction X even when the flow of a refrigerant is confused by flowing crevice 42B crosswise [Y], a uniform flow can be formed in a longitudinal direction X also in the crevice 42 between the front faces of a coil 40. Furthermore, since the refrigerants which cooled the coil 40 and changed into the elevated-temperature state are promptly collected through pore 54 on the 2nd mainstream way 52 of the inside, the stagnation of the refrigerant on a coil 44 is prevented and they can prevent a local elevated-temperature state. As for the above-mentioned pore 54, it is desirable to form many as much as possible, and it is made the shape of a slit and you may make it extend the passage cross section of pore 54 from this viewpoint.

[0062] Moreover, since the 1st mainstream way 70 of an outside (the refrigerant of a low-temperature state is introduced most) intervenes between a clamp face 60 and a coil 40, the amount of heat transfer to a clamp face 60 is suppressed, and the thermal expansion by the side of a partner machine is reduced sharply.
[0063] Furthermore, in the **** 1 operation gestalt, since a refrigerant moves in order of the feed-holes 72 -> run through-hole 78 -> exhaust pipe 55, if it thinks on the whole, the countercurrent flow is formed in the longitudinal direction X. Especially, between the 1st mainstream way 70 of an outside, the 2nd mainstream way 52 of the inside and the 2nd mainstream way 76 of an outside, and the inside mainstream way 56, the countercurrent flow is formed clearly, and uniform cooling of a longitudinal direction X is attained by this. Moreover, since feed holes 72 and an exhaust pipe 55 approach, an external piping design becomes very easy.
[0064] Although the refrigerant of an elevated-temperature state will pass most to an exhaust pipe 55, since the 1st mainstream way 70 encloses the circumference of this exhaust pipe 54 (refer to drawing 6), heat transfer to the clamp face 60 from this exhaust pipe 55 can be reduced, and the thermal expansion of the other party machine is reduced by this.
[0065] Next, with reference to drawing 8 and drawing 9 , the coil unit 132 concerning the 2nd operation gestalt of this invention is explained. In addition, about a portion, a member, etc. which are not explained concretely below, since it is the same as that of the coil unit 32 concerning the above-mentioned 1st operation gestalt almost, into the same portion, detailed explanation of composition, an operation, etc. abbreviates 2 figures to this coil unit 32 the bottom by ****** which attaches the same sign.
[0066] Two or more run through-holes 178 which supply a refrigerant to the interior of shell 144 are formed in the 2nd mainstream way 176 of an outside in this coil unit 132 at intervals of predetermined at the longitudinal direction X. the [this / outside] -- 2 mainstream ways 176 -- these free passages -- a direct refrigerant can be supplied to a crevice 42 through a hole 178 Therefore, the inside mainstream way 56 in the coil unit 32 of the 1st operation gestalt is not formed (it can be said that the 2nd mainstream way 176 of an outside serves as the function of an inside mainstream way).
[0067] Also in this coil unit 132, while a refrigerant is guided by the 1st mainstream way 170 of an outside at a longitudinal direction X, it is drawn crosswise [Y] through the branch passage 174. the [furthermore, / outside] -- 2 mainstream ways 176 -- also setting -- two or more free passages -- pass a hole 178 -- a refrigerant is drawn crosswise [Y] Therefore, by diffusion of the refrigerant of a longitudinal direction X, and the countercurrent flow of the cross direction Y, an effect almost equivalent to the above-mentioned 1st operation gestalt can be acquired, and a internal structure can be further made briefer than the 1st operation gestalt.
[0068] the [in addition, / above / the 1st and] -- 2 operation gestalten -- setting -- the branch passage 74 and a free passage -- although the case where the hole 178 was arranged at equal intervals at the longitudinal direction was shown, this invention is not limited to it Moreover, there is especially no limit also about the length and the configuration of the branch passage 74 or the run through-hole 178.
[0069] Furthermore, the concept of pouring the refrigerant in this invention crosswise [Y] takes into consideration the case where a coil unit is seen on the whole. That is, it is within the limits which this invention assumes though this invention is positively passed crosswise to having poured the refrigerant positively to a longitudinal direction conventionally and some gaps and stagnation are in the flow of the cross direction of a refrigerant.
[0070] Although the coil unit 32,132 shown above has put the chief aim on preventing the influence of heat transfer to the exterior of a coil 40, if a refrigerant is poured on the

contrary in this structure, it can acquire the thermolysis structure of reducing the temperature rise of a coil itself as much as possible (if it is made to flow backwards).
[0071] What is necessary is to let the 1st guidance way and the inside mainstream way 56 into the 2nd guidance way, and just to let [an exhaust pipe 55] feed holes 72 be a discharge hole for a supply pipe and the 2nd mainstream way 52 of the inside in the coil unit 32 specifically shown by drawing 5 . If it does in this way, the refrigerant supplied from a supply pipe (exhaust pipe 55) will be guided by the 1st guidance way (the [inside] 2 mainstream ways 52) at a longitudinal direction X, and a refrigerant will be drawn crosswise [Y] by the front face of a coil 40 through pore 54. The refrigerant which cooled the coil 40 is caught by the 2nd guidance way (inside mainstream way 56), and is drawn by crevice 42B of shell 44 and the outside covering 64. Finally the refrigerant which cooled the coil 40 positively by heat being effectively emitted outside by the outside covering 64 will be discharged from a discharge hole (feed holes 72).
[0072]
[Effect of the Invention] According to the coil unit concerning this invention, while raising the cooling efficiency of a coil sharply, heat transfer over a surrounding atmosphere and a surrounding partner machine can be suppressed sharply. Therefore, the positioning accuracy of the partner machine by the linear motor can be raised.

TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to the technology which cools a coil with a refrigerant especially about the coil unit equipped with the coil by which opposite arrangement is carried out at the magnet in a linear motor, and the shell which holds this coil in the interior and cools this coil through a refrigerant in the crevice between selves for linear motors.

PRIOR ART

[Description of the Prior Art] an aligner, a high precision finishing machine, etc. for the conventional, for example, semiconductor, manufacture -- setting -- an object (for example, the wafer and workpiece which are exposed) -- high degree of accuracy -- and to position quickly is demanded In this case, as a precision pointing device used, what changes rotation of a rotated type motor into rectilinear motion by the ball thread etc., the rectilinear-motion type motor (the so-called linear motor), etc. are used widely.
[0003] Also in this, structure of a linear motor is brief, part mark end few, and have the merit that the direct use of the rectilinear motion can be carried out further, and it can position an object quickly. Moreover, since there is little frictional resistance at the time of a drive, it also has the feature that a precision of operation can be raised. It is becoming in use [the above reason to a linear motor] as a straight-line driving gear of all fields with which precise positioning is demanded, for example, the manufacturing process of a liquid crystal display is also used widely.
[0004] Generally this linear motor consists of a magnetic pole unit equipped with the magnet, and a coil unit equipped with the coil. A magnetic pole unit or a coil unit is connected with a predetermined pedestal, it functions as a stator, and another side is connected with a move table etc. and functions as a needle. The fixed crevice is left so that it may not contact mutually, and where the crevice is maintained, rectilinear motion of this magnetic pole unit and the coil unit is carried out relatively.

[0005] By the way, the coil prepared in the above-mentioned coil unit will generate heat, if current is supplied. This generation of heat is transmitted to the whole coil unit, and is further transmitted to a pedestal, a move table, etc. which have been combined with this coil unit. Consequently, two problems as shown below occur.
[0006] (1) It becomes the factor which the coil unit itself and the other party machine connected with this coil unit expand thermally [factor], and makes positioning accuracy produce an error with the heat of a coil. Specifically, if the other party machine connected with a coil unit was low-fever expansion material (coefficient of thermal expansion 1x10-6) with a length of 100mm, 100nm heat deformation arises by the 1-degree C temperature rise. Therefore, when the positioning accuracy of nano meter order is required, this thermal expansion cannot become a cause and a demand cannot fully be filled.
[0007] (2) Near the linear motor, the laser interferometer which measures movement of this linear motor is installed. If a surrounding atmosphere is heated by the coil unit and "fluctuation" occurs by it, the optical path of a laser beam will be affected and a measurement error will arise.
[0008] Here, a refrigerant is poured between the clamp face of the other party machine in a coil unit, and a coil as what solves the problem of (1), and the technology of preventing transfer of the heat from a coil is known. However, in this technology, the temperature rise of the atmosphere around a coil unit could not be suppressed, and the trouble of (2) was not solved after all.
[0009] Then, the coil unit 10 as shown in drawing 10 and drawing 11 is proposed as what solves the problem of the both sides of (1) and (2) collectively. This coil unit 10 is used for a linear motor 1, and opposite arrangement is carried out at the magnet 3 of the magnet unit 2.
[0010] Concretely, this coil unit 10 equips a magnet 3 with the shell 14 which can cool a coil 12 through a refrigerant in the crevice 13 between a coil 12 and self while holding the plate-like long coil 12 and this coil 12 in the interior at the travelling direction X by which opposite arrangement is carried out. On the other hand, the magnet unit 2 is equipped with the cross-section KO character-like base 4, and the above-mentioned magnets 3 and 3 are attached in wall 4A countered in this base 4.
[0011] The clamp face 16 to the other party machine is formed in the outside of one edge 14A of the cross direction Y in shell 14, the feed holes 18 which supply a refrigerant to the crevice 13 between shell 14 are formed in the end side of the longitudinal direction X of this clamp face 16, and the discharge hole 20 which discharges this refrigerant is formed in the other end side. When the coil unit 10 is connected with a "fixed side" other party machine through this clamp face 16, the coil unit 10 serves as a stator and the magnet unit 2 serves as a needle. On the contrary, when the coil unit 10 is connected with a "movement side" partner machine, the coil unit 10 serves as a needle and the magnet unit 2 serves as a stator.
[0012] The refrigerant supplied from feed holes 18 is diffused in the crevice 13 between a coil 12 and shell 14, and delivers and receives heat between coils 12. Therefore, the coil 12 which generates heat by current is cooled, and a refrigerant is heated. Since the heated refrigerant is discharged from a discharge hole 20, heat is not accumulated inside the coil unit 10, but the radiation to a surrounding atmosphere is reduced. Therefore, this linear motor 1 can lessen influence on the exterior by generation of heat of a coil 12, and highly precise positioning is possible for it.

EFFECT OF THE INVENTION

[Effect of the Invention] According to the coil unit concerning this invention, while raising the cooling efficiency of a coil sharply, heat transfer over a surrounding atmosphere and a surrounding partner machine can be suppressed sharply. Therefore, the positioning accuracy of the partner machine by the linear motor can be raised.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in such a coil unit 10, it was not necessarily able to be said that sufficient cooling effect was acquired. if the diffusion situation of the refrigerant in shell 14 is concretely shown in drawing 12 typically -- a refrigerant -- A, B, and C -- it becomes ... with a parallel flow with a breadth gradually, and it is discharged from a discharge hole 20, converging with F, G, and H finally Since a refrigerant is heated as it moves to a downstream, as mostly in agreement with the order of this A and B, C...E, and G and H, temperature will rise.

[0014] The temperature of the refrigerant in this result, especially the downstream (E, G, H) neighborhood was rising sharply as compared with the upstream, and it had the problem that heat transmitted to shell 14 through the refrigerant of this elevated-temperature state, and it was radiated outside while cooling efficiency fell. Furthermore, heat transmitted to the clamp face 16 through the refrigerant of the elevated-temperature state of a downstream, and it had also become the cause which induces the thermal expansion by the side of a partner machine.

[0015] And this property is generated unescapable, even if the pressure (supply pressure) of a refrigerant and the size of a crevice are designed comparatively good. Moreover, when a design was not good, it is the situation which the portion into which a refrigerant hardly flows tends to produce, and there was fault also with a bird clapper much more notably.

[0016] Although the flow rate of a refrigerant was increased and cooling efficiency needed to be raised in order to solve these, when the large crevice 13 was taken for flow rate increase, the magnet 3 by the side of the magnet unit 2 and the distance S between three (refer to drawing 1) became large, flux density became small, and there was a problem that the driving force of a linear motor 1 decreased. Moreover, when the flow rate of a refrigerant was increased, thickness of shell 14 needed to be thickened, pressure resistance needed to be raised, and this thick increase also affected the fall of the driving force (thrust) of a linear motor 1.

[0017] On the other hand, the demand of wanting to suppress the temperature rise of a linear motor on still higher level is increasing with the advancement of a manufacture process in recent years. However, there is a limitation in the refrigeration capacity of the coil 12 in the coil unit 10, and the present condition is that it cannot be satisfied [with the situation that fixed restrictions are imposed on the thickness of shell 14, the size of a crevice 13, etc.] of the above-mentioned demand.

[0018] this invention is made in view of the trouble relevant to uneven cooling and the shortage of refrigeration capacity of the coil by the refrigerant as shown above, and aims at reducing the temperature rise of a coil unit by leaps and bounds than before according to the new cooling structure using the refrigerant.

MEANS

[Means for Solving the Problem] While this invention leaves a predetermined crevice and holds the coil by which opposite arrangement is carried out at the magnet of a linear motor, and this coil in the interior While leaving a predetermined crevice and holding shell in the interior in the coil unit used for the linear motor which equipped this crevice with the shell which can cool this coil through the refrigerant While introducing in self the refrigerant which is prolonged and formed in this crevice through a refrigerant at a longitudinal direction near the crosswise end edge of the shell in outside covering which can cool shell, and this outside covering, and is supplied from the outside While receiving the refrigerant which was prolonged and formed in the outside surface of shell in this refrigerant at the longitudinal direction the 1st mainstream way of an outside which can be derived crosswise, and near the crosswise other end edge of the shell in outside covering, and has flowed the outside surface of shell crosswise through the 1st mainstream way of an outside The above-mentioned purpose is attained by having the exhaust pipe which can be discharged outside for the refrigerant which has flowed the 2nd mainstream way of an outside which can be supplied in shell, and the coil front face in shell in this refrigerant.
[0020] In this coil unit, the double cooling structure by arranging outside covering in the circumference of shell further was adopted. Moreover, further, it is shown to a refrigerant by the 1st mainstream way of an outside at the longitudinal direction of a coil (low-temperature state), and first has the structure where a refrigerant (turning to an other end side from an end side) flows the crevice between shell and outside covering crosswise through this 1st mainstream way of an outside, by it. this refrigerant -- the [outside] -- pass 2 mainstream ways -- the interior of shell is supplied -- having -- a coil front face -- the cross direction -- (-- it flows from an other end side to) towards an end side, and is discharged from an exhaust pipe (in the state where it became an elevated temperature most)
[0021] therefore, the thing for which equalization of cooling is attained by the longitudinal direction -- in addition, since it is the structure which cools a coil front face and a shell outside surface by the so-called countercurrent flow, crosswise equalization is also attained, the whole coil unit is covered, and temperature tends to become uniform, and cooling efficiency is also raised more sharply than before Consequently, the local temperature rise of a surrounding atmosphere is prevented.
[0022] moreover, it was supplied in outside covering -- with the refrigerant of a low-temperature state, just before being discharged in shell, the refrigerant of an elevated-temperature state is covered most Moreover, near the crosswise middle, the refrigerant which flows the inside of outside covering and which changed into the elevated-temperature state moderately (cooling a coil) in shell is moderately covered with the refrigerant of a low-temperature state. Thus, since heat transfer of a coil is suppressed outside by existence of the refrigerant in outside covering very rationally from inside, the temperature rise of a coil unit can be reduced by it more sharply than before.
[0023] In addition, it sets to the above-mentioned invention, and while introducing in self the aforementioned refrigerant supplied from the 2nd mainstream way of an outside, you may make it to be prolonged and formed in the 2nd mainstream road side of an outside in shell at a longitudinal direction, and equip the front face of the coil in the aforementioned shell with the inside mainstream way which can be derived crosswise for a refrigerant further.
[0024] Since according to this structure it is drawn by the coil front face after a refrigerant is again introduced into a longitudinal direction by the inside mainstream way even if it is the case (confused) where the flow of a refrigerant becomes uneven by having flowed to the 2nd mainstream way of an outside, uniform cooling of a coil is attained.
[0025] It is prolonged and formed in the 1st mainstream road side of an outside in shell at a

longitudinal direction, and while receiving the refrigerant which has flowed the coil front face in shell crosswise, you may make it have further the 2nd mainstream way of the inside which can discharge this refrigerant from an exhaust pipe in the above-mentioned invention.

[0026] The refrigerant which became an elevated temperature by cooling a coil must be discharged outside as promptly as possible, and must suppress the influence of the heat to the circumference. Then, since according to this structure the refrigerant of an elevated-temperature state is promptly discharged first by the 2nd mainstream way of the inside and is not overdue to the circumference of a coil, the local elevated-temperature state on a coil is prevented.

[0027] Furthermore, since the 2nd mainstream way of the inside of a longitudinal direction where this refrigerant (elevated-temperature state) is introduced can be covered by the 1st mainstream way of an outside of a longitudinal direction where the refrigerant of a low-temperature state is introduced most, heat transfer to circumference atmosphere or a machine clamp face is suppressed. In addition, the machine clamp face which attaches this coil unit in the other party machine has the desirable 1st mainstream road side of an outside in the periphery of outside covering so that clearly from the above-mentioned contents. This is because heat transfer from a coil is intercepted by this 1st mainstream way of an outside.

[0028] Moreover, in the above-mentioned invention, while forming in the longitudinal direction end close-attendants side of outside covering the feed holes which can supply a refrigerant to the 1st mainstream way of an outside It is desirable to arrange the exhaust pipe which can form the run through-hole which can be supplied in shell for the refrigerant guided into self at the longitudinal direction other end close-attendants side of the 2nd mainstream way of an outside, and can discharge the refrigerant in this shell in the aforementioned equivalent position near the feed holes in shell.

[0029] thus -- if it carries out -- a feed-holes -> free passage -- a hole -- since a refrigerant moves in order of -> exhaust pipe, if it ******, a refrigerant will be supplied from feed holes, and it will move in the diagonal line top of a coil unit, and will become the cooling structure which returns to near the feed holes again and is discharged from an exhaust pipe Therefore, the whole coil can be covered, the still more uniform cooling effect can be acquired, and suppression becomes possible on still higher level about the temperature rise of a surrounding atmosphere. Moreover, since a supply and eccrisis side approaches, an external piping design becomes easy.

[0030] Furthermore, if it is desirable to arrange near the downstream of feed holes [in / the 1st mainstream way of an outside / for the above-mentioned exhaust pipe] as it penetrates and it does in this way The heat which a coil generates after only the refrigerant in an exhaust pipe has got warm is recoverable, suppressing the local temperature rise of the coil unit near the exhaust pipe, since the peripheral face of the exhaust pipe which the refrigerant of an elevated-temperature state passes most is cooled with the refrigerant which flows the 1st mainstream way of an outside. In addition, it is located in the longitudinal direction inside near the downstream of feed holes rather than feed holes, and they are being close to these feed holes, and abbreviation homonymy.

[0031] the [moreover, / in all the above-mentioned invention / outside] -- as a means by which 1 mainstream way derives a refrigerant crosswise to the outside surface of shell -- the [for example, / outside] -- the branch passage of plurality [way / mainstream / 1] -- a longitudinal direction predetermined interval -- forming -- the / this / outside / -- it is desirable to branch the refrigerant introduced in 1 mainstream way by each of two or more of these branch passage, and to enable derivation crosswise of it at the outside surface of In addition, the number of these branch passage, a configuration, length, etc. are not limited at

all, and, in short, just derive a refrigerant crosswise.
[0032] Furthermore, it is desirable to form in the down-stream edge of this branch passage the subpassage of the longitudinal direction which can once be stored for the aforementioned refrigerant drawn from this branch passage, and to enable derivation of this refrigerant through subpassage at the outside surface of the aforementioned shell. Since according to this structure it is drawn by the outside surface of shell while the refrigerant drawn from each branch passage is spread in a longitudinal direction by subpassage and a pressure and a flow rate are equalized by the longitudinal direction, the homogeneity of the temperature distribution of the peripheral face of a coil unit can be raised. Moreover, by branch passage, since the pressure of a refrigerant [in / the 1st mainstream way / by 1 or subpassage] is spread in a longitudinal direction and flows in crosswise, though it is also possible to make thickness of outside covering or shell thin and it is made into double cooling structure, a coil unit can be constituted comparatively compactly.
[0033] By the way, it is one side, and if a refrigerant is poured to opposite direction, it comes to be able to do usage which raised the "thermolysis nature" of a coil unit more, although it sets it as the main purposes that the above thought suppresses the thermal effect which a coil unit has on a surrounding atmosphere and a surrounding partner machine.
[0034] While leaving a predetermined crevice and specifically holding the coil by which opposite arrangement is carried out at the magnet of a linear motor, and a coil in the interior While leaving a predetermined crevice and holding shell in the interior in the coil unit used for the linear motor which equipped the crevice with.the shell which can cool this coil through the refrigerant Through a refrigerant, near the crosswise end edge of outside covering which can cool this shell, and the coil in shell, it is prolonged in a longitudinal direction and formed at it between these. While introducing in self the refrigerant supplied from the outside, this refrigerant The 1st guidance way which can be derived crosswise on the surface of a coil, While receiving the refrigerant which was prolonged and formed in the longitudinal direction near the crosswise other end edge of the coil in shell, and has flowed the front face of a coil crosswise through the 1st guidance way What is necessary is just to have the discharge hole which can be discharged outside for the refrigerant which has flowed the 2nd guidance way which can be supplied to the crevice between shell and outside covering, and the shell outside surface in this refrigerant.
[0035] In short, this invention considers conversely the flow (the upstream, lower stream of a river) of the refrigerant of structure explained so far.
[0036] If it does in this way, the heat of a refrigerant will be emitted outside because the refrigerant of a low-temperature state cools a coil front face first and flows the crevice between shell and outside covering after that. Therefore, since a coil can be cooled positively, it is suitable when the temperature rise of a coil itself needs to be especially reduced as much as possible in a mass linear motor (suppression of the temperature rise of a surrounding atmosphere). In addition, what is necessary is just to apply reversely all the things that also showed still more detailed structure above.
[0037]
[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained in detail, referring to a drawing.
[0038] The coil unit 32 used for the linear motor 30 concerning the 1st operation gestalt is shown in drawing 1 and drawing 2 .
[0039] While the coil unit 32 leaves the predetermined crevice 42 and holds the plate-like coil 40 long to the travelling direction X (refer to drawing 2) by which opposite arrangement is carried out at the magnets 36 and 36 of the magnet unit 34, and this coil 40 in the interior While breaking predetermined crevice 42B in this crevice 42 and holding in it the shell 44 which can cool a coil 40, and this shell 44 in the interior through a

refrigerant, this crevice 42B is equipped with the outside covering 64 which can cool shell 44 through a refrigerant. In addition, this magnet unit 34 is equipped with the cross-section KO character-like base 38, and is the structure where the above-mentioned magnets 36 and 36 were attached in wall 38A of this base 38.

[0040] The cross section perpendicular to travelling direction X has become I character-like (saddle type), and more specifically, the piece 46 of a coil shown in drawing 3 combines two or more plate-like coils 40, they are carried out, and are constituted. Although this piece 46 of a coil coils copper wire in the shape of a ring, it is orthopedically operated as a whole so that the ends of bay 46A and this bay 46A may be equipped with flection 46B by which incurvation formation is carried out (exterior). Therefore, as shown in drawing 4 , two or more pieces 46 of a coil are combined by turns so that bay 46A may overlap, and the above-mentioned I character-like coil 40 is constituted for U layers of V layers of W layers of ..., then cross sections in order of travelling direction X. In the state with this, since it is not connected mutually but decomposes, as shown in drawing 2 , the mould of this coil 40 is really carried out with Resin G with the coil electrode holder 48 of the longitudinal direction arranged at the crosswise Y end marginal 40A side.

[0041] Shell 44 is a member which holds a coil 40 in the interior, and is equipped with the plate 50 made from stainless steel connected with the above-mentioned coil electrode holder 48 and this above-mentioned coil electrode holder 48. As a plate 50 meets in the shape of [of a coil 40] a cross section of I characters, it is crooked, and where a coil 40 is held in the interior, the predetermined crevice 42 is formed in bay 46A of this coil 40.

[0042] The outside covering 64 is a member which holds shell 44 in the interior, equips the travelling direction X attached in crosswise Y outside of the coil electrode holder 48 with the long outer cover 66 and the outside plate 68 made from stainless steel connected with this outer cover 66, and is constituted. As the outside plate 68 meets the plate 50 of shell 44, it is crooked on it, and where shell 44 is held in the interior, predetermined crevice 42B is formed (in bay 46A considerable position of a coil 40).

[0043] Next, with reference to drawing 1 and drawing 5 - drawing 7 , the cooling structure of the coil 40 in the coil unit 32 is explained in detail.

[0044] As shown in drawing 5 and drawing 6 , near the crosswise end marginal 44A of the shell 44 in the outside covering 64, the 1st mainstream way 70 of an outside prolonged in a longitudinal direction (it is the same as travelling direction) X is formed. The feed holes 72 which can supply a refrigerant to this 1st mainstream way 70 of an outside are formed in the longitudinal direction end 70A close-attendants side of this 1st mainstream way 70 of an outside, and the refrigerant supplied from these feed holes 72 is guided by the 1st mainstream way 70 of an outside at a longitudinal direction X.

[0045] Two or more branch passage 74 is formed in this 1st mainstream way 70 of an outside at intervals of longitudinal direction X predetermined. The refrigerant introduced by this branch passage 74 in the 1st mainstream way 70 of an outside branches, and the outside surface (crevice 42B) of shell 44 is flowed crosswise [Y].

[0046] The 2nd mainstream way 76 of an outside prolonged in a longitudinal direction X is formed in the crosswise other end marginal 44B close-attendants side of the shell 44 in the outside covering 64. the [this / outside] -- the 2 mainstream passage 76 -- the [outside] -- pass 1 mainstream way 70 and the branch passage 74 -- while receiving the refrigerant which has flowed outside-surface 44C (crevice 42B) of shell 44 crosswise [Y], this refrigerant is supplied to the interior of shell 44 In addition, this 2nd mainstream way 76 of an outside is formed by extending the crevice between a plate 50 and the outside plate 68 (crevice 42B near the bay 40A of a coil 40).

[0047] The subpassage 78 of the longitudinal direction X which can once be stored is formed in down-stream edge 74A (refer to drawing 1) of the above-mentioned branch

passage 74 in the refrigerant drawn from here. This subpassage 78 has structure which derives this refrigerant to crevice 42B while storing a refrigerant, and it has the so-called role like a buffer. In addition, this subpassage 78 is formed by extending the crevice between a plate 50 and the outside plate 68 rather than the above-mentioned crevice 42B.
[0048] In addition, the above-mentioned 1st mainstream way 70 of an outside and the branch passage 74 form a slot in the wall of an outer cover 66 by cutting etc., and should just consist of aforementioned slots in the state where this outer cover 66 was attached in the coil electrode holder 48.
[0049] Next, the cooling structure inside shell 44 is explained.
[0050] As shown in drawing 5 , the inside mainstream way 56 prolonged in the 2nd mainstream way 76 side of an outside at a longitudinal direction X is formed in the interior of shell 44. That is, the 2nd mainstream way 76 of an outside and the inside mainstream way 56 are arranged in parallel. the [this / outside] -- the free passage which connects these with longitudinal direction X other end side of 2 mainstream way 76 and inside mainstream way 56 56B (namely, the feed holes 72 and the opposite side in a longitudinal direction X) -- a hole 78 forms -- having -- **** -- this free passage -- a hole 78 -- minding -- the [outside] -- the refrigerant guided in 2 mainstream ways 76 is supplied to the inside mainstream way 56 in addition, passage formation of the longitudinal direction X by which this inside mainstream way 56 has been arranged in shell 44 -- it is constituted by forming a slot in a member 57
[0051] Two or more ramus-medialis passage 56A at a predetermined interval is formed in this inside mainstream way 56 at the longitudinal direction X, and the refrigerant guided in the inside of the inside mainstream way 56 at the longitudinal direction X is drawn crosswise [Y] by the front face of a coil 40 through this ramus-medialis passage 56A (in crevice 42). In detail, this branch passage 56A is formed in the three directions for every predetermined interval, respectively (refer to drawing 1), and the refrigerant drawn from each flows to the crevice 42 side.
[0052] As shown in drawing 7 , the 2nd mainstream way 52 of the inside which receives the refrigerant which has flowed the front face of a coil 40 crosswise [Y] is formed in the 1st mainstream way 70 side of an outside in shell 44. Pore 54 is formed in this 2nd mainstream way 52 of the inside at intervals of longitudinal direction X predetermined (refer to drawing 1), and the refrigerant which has flowed the front face of a coil 40 flows into the 2nd mainstream way 52 of the inside through two or more pores 54. Furthermore, the exhaust pipe 55 which can discharge the refrigerant collected by this 2nd mainstream way 52 of the inside is formed in the end 52A side of the longitudinal direction X in this 2nd mainstream way 52 of the inside. More specifically, the above-mentioned exhaust pipe 55 penetrates and opening of near the downstream of the feed holes 72 in the 1st mainstream way 70 of an outside is carried out to an outer cover 66 side. That is, the 1st mainstream way 70 of an outside encloses the circumference of an exhaust pipe 55 (refer to drawing 6).
[0053] In addition, what is necessary is just to form the 2nd mainstream way 52 of the inside, and the pore 54 grade in the coil electrode holder 48 before really carrying out the mould of the coil 40 by cutting etc.
[0054] Next, an operation of this coil unit 32 is explained.
[0055] The refrigerant supplied from feed holes 72 is guided by the 1st mainstream way 70 of an outside at a longitudinal direction X. If the pressure of this 1st mainstream way 70 of an outside increases, a refrigerant will flow into the subpassage 78 through the branch passage 74. Since the amount of refrigerants introduced into the subpassage 78 is already considerably equalized by the function of the 1st mainstream way 70 of an outside in the longitudinal direction X from each branch passage 74, the pressure of the refrigerant in the

subpassage 78 is further equalized in the longitudinal direction X. And the refrigerant in this subpassage 78 flows into crevice 42B crosswise [Y].

[0056] The refrigerant which cooled outside-surface 44C of shell 44 through this crevice 42B flows into the 2nd mainstream way 76 of an outside, and is guided at a longitudinal direction X. This refrigerant is supplied to the inside mainstream way 56 from the run through-hole 78, and is guided at the above-mentioned guidance direction and above-mentioned opposite direction of the 2nd mainstream way 76 of an outside. If the pressure of the refrigerant in this inside mainstream way 56 increases, this refrigerant flows out of ramus-medialis passage 56A, and fills the interior of shell 44. The refrigerant which flowed along the cross direction Y and cooled the coil 40 flows in in the 2nd mainstream way 52 of the inside through pore 54. The refrigerant which flowed in in this 2nd mainstream way 52 of the inside is guided at a longitudinal direction X, and is discharged from an exhaust pipe 55.

[0057] According to this coil unit 32, it has wrap dual structure with shell 44 and the outside covering 64 in the coil 40. Furthermore, while a refrigerant is guided by the 1st mainstream way 70 of an outside, and the inside mainstream way 56 at a longitudinal direction X (diffusion), it is the structure which flows out crosswise [Y] after that. Therefore, in each crevices 42 and 42B, the countercurrent flow of the cross direction Y is formed relatively.

[0058] Since uniform cooling is attained in both directions of a longitudinal direction X and the cross direction Y by diffusion of the longitudinal direction X of these refrigerants, and crosswise Y countercurrent flow, the whole coil unit 32 can be covered and temperature can be made uniform by them. Consequently, even if it does not increase the flow rate of a refrigerant, as compared with the former, cooling efficiency can be raised sharply.

[0059] For example, according to the analysis result by this invention person, when the flow rate of 200 (W) and a refrigerant is temporarily set to 2 (l/min) for the calorific value of a coil, the temperature of the outside surface of the conventional coil unit is stopped by about 0.45-degree C temperature rise in the coil unit 32 of a **** 1 operation gestalt to going up by about 2.5 degrees C. In addition, although the above-mentioned analysis result changes with the quality of the material of shell, or kinds of refrigerant, the result which was extremely excellent in the case of which can be obtained.

[0060] Especially the refrigerant that flows crevice 42B of the outside covering 64 and shell 44 intercepts effectively the influence of heat transfer to the exterior of a coil 40, and has wrap structure with the refrigerant of a low-temperature state most in the portion of shell 44 which serves as an elevated temperature most. That is, since the low-temperature refrigerant which just flowed to outside crevice 42B will cover the hot refrigerant in front of the recovery in shell 44, in addition to improvement in the cooling efficiency of a coil 40, it can reduce sharply the amount of heat transfer to external atmosphere.

[0061] Moreover, since it is collected by the 2nd mainstream way 76 of an outside and the inside mainstream way 56 shows around again at a longitudinal direction X even when the flow of a refrigerant is confused by flowing crevice 42B crosswise [Y], a uniform flow can be formed in a longitudinal direction X also in the crevice 42 between the front faces of a coil 40. Furthermore, since the refrigerants which cooled the coil 40 and changed into the elevated-temperature state are promptly collected through pore 54 on the 2nd mainstream way 52 of the inside, the stagnation of the refrigerant on a coil 44 is prevented and they can prevent a local elevated-temperature state. As for the above-mentioned pore 54, it is desirable to form many as much as possible, and it is made the shape of a slit and you may make it extend the passage cross section of pore 54 from this viewpoint.

[0062] Moreover, since the 1st mainstream way 70 of an outside (the refrigerant of a low-temperature state is introduced most) intervenes between a clamp face 60 and a coil 40, the

amount of heat transfer to a clamp face 60 is suppressed, and the thermal expansion by the side of a partner machine is reduced sharply.
[0063] Furthermore, in the **** 1 operation gestalt, since a refrigerant moves in order of the feed-holes 72 -> run through-hole 78 -> exhaust pipe 55, if it thinks on the whole, the countercurrent flow is formed in the longitudinal direction X. Especially, between the 1st mainstream way 70 of an outside, the 2nd mainstream way 52 of the inside and the 2nd mainstream way 76 of an outside, and the inside mainstream way 56, the countercurrent flow is formed clearly, and uniform cooling of a longitudinal direction X is attained by this. Moreover, since feed holes 72 and an exhaust pipe 55 approach, an external piping design becomes very easy.
[0064] Although the refrigerant of an elevated-temperature state will pass most to an exhaust pipe 55, since the 1st mainstream way 70 encloses the circumference of this exhaust pipe 54 (refer to drawing 6), heat transfer to the clamp face 60 from this exhaust pipe 55 can be reduced, and the thermal expansion of the other party machine is reduced by this.
[0065] Next, with reference to drawing 8 and drawing 9 , the coil unit 132 concerning the 2nd operation gestalt of this invention is explained. In addition, about a portion, a member, etc. which are not explained concretely below, since it is the same as that of the coil unit 32 concerning the above-mentioned 1st operation gestalt almost, into the same portion, detailed explanation of composition, an operation, etc. abbreviates 2 figures to this coil unit 32 the bottom by ****** which attaches the same sign.
[0066] Two or more run through-holes 178 which supply a refrigerant to the interior of shell 144 are formed in the 2nd mainstream way 176 of an outside in this coil unit 132 at intervals of predetermined at the longitudinal direction X. the [this / outside] -- 2 mainstream ways 176 -- these free passages -- a direct refrigerant can be supplied to a crevice 42 through a hole 178 Therefore, the inside mainstream way 56 in the coil unit 32 of the 1st operation gestalt is not formed (it can be said that the 2nd mainstream way 176 of an outside serves as the function of an inside mainstream way).
[0067] Also in this coil unit 132, while a refrigerant is guided by the 1st mainstream way 170 of an outside at a longitudinal direction X, it is drawn crosswise [Y] through the branch passage 174. the [furthermore, / outside] -- 2 mainstream ways 176 -- also setting -- two or more free passages -- pass a hole 178 -- a refrigerant is drawn crosswise [Y] Therefore, by diffusion of the refrigerant of a longitudinal direction X, and the countercurrent flow of the cross direction Y, an effect almost equivalent to the above-mentioned 1st operation gestalt can be acquired, and a internal structure can be further made briefer than the 1st operation gestalt.
[0068] the [in addition, / above / the 1st and] -- 2 operation gestalten -- setting -- the branch passage 74 and a free passage -- although the case where the hole 178 was arranged at equal intervals at the longitudinal direction was shown, this invention is not limited to it Moreover, there is especially no limit also about the length and the configuration of the branch passage 74 or the run through-hole 178.
[0069] Furthermore, the concept of pouring the refrigerant in this invention crosswise [Y] takes into consideration the case where a coil unit is seen on the whole. That is, it is within the limits which this invention assumes though this invention is positively passed crosswise to having poured the refrigerant positively to a longitudinal direction conventionally and some gaps and stagnation are in the flow of the cross direction of a refrigerant.
[0070] Although the coil unit 32,132 shown above has put the chief aim on preventing the influence of heat transfer to the exterior of a coil 40, if a refrigerant is poured on the contrary in this structure, it can acquire the thermolysis structure of reducing the temperature rise of a coil itself as much as possible (if it is made to flow backwards).

[0071] What is necessary is to let the 1st guidance way and the inside mainstream way 56 into the 2nd guidance way, and just to let [an exhaust pipe 55] feed holes 72 be a discharge hole for a supply pipe and the 2nd mainstream way 52 of the inside in the coil unit 32 specifically shown by drawing 5 . If it does in this way, the refrigerant supplied from a supply pipe (exhaust pipe 55) will be guided by the 1st guidance way (the [inside] 2 mainstream ways 52) at a longitudinal direction X, and a refrigerant will be drawn crosswise [Y] by the front face of a coil 40 through pore 54. The refrigerant which cooled the coil 40 is caught by the 2nd guidance way (inside mainstream way 56), and is drawn by crevice 42B of shell 44 and the outside covering 64. Finally the refrigerant which cooled the coil 40 positively by heat being effectively emitted outside by the outside covering 64 will be discharged from a discharge hole (feed holes 72).

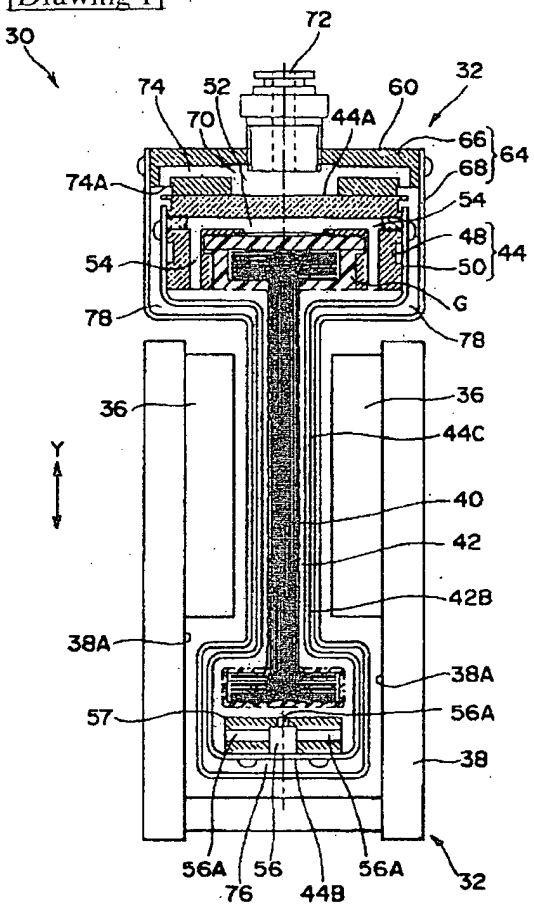
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The cross section showing the linear motor to which the coil unit concerning the 1st operation gestalt of this invention is applied
[Drawing 2] The perspective diagram showing this linear motor partially
[Drawing 3] The perspective diagram showing the piece of a coil used for this coil unit
[Drawing 4] The perspective diagram showing the coil constituted combining this piece of a coil two or more
[Drawing 5] The fragmentary sectional view showing the cooling structure of this coil unit
[Drawing 6] The VI-VI cross section of drawing 5
[Drawing 7] The VII-VII cross section of drawing 5
[Drawing 8] The cross section showing the coil unit concerning the 2nd operation gestalt of this invention
[Drawing 9] The IX-IX cross section of drawing 8
[Drawing 10] The cross section showing the conventional linear motor
[Drawing 11] 11 to 11 cross section of drawing 10
[Drawing 12] The ** type view showing the diffusion situation of the refrigerant in the coil unit of this linear motor
[Description of Notations]
30 -- Linear motor
32,132 -- Coil unit
34 -- Magnet unit
36 -- Magnet
42, 42B, 142, 142B -- Crevice
44,144 -- Shell
44A, 144A -- End edge
44B, 144B -- Other end edge
52,152 -- The 2nd mainstream way of the inside
54,154 -- Pore
55,155 -- Exhaust pipe
56 -- Inside mainstream way
60,160 -- Clamp face
64,164 -- Outside covering
66,166 -- Outer cover
68,168 -- Outside plate
70,170 -- The 1st mainstream way of an outside

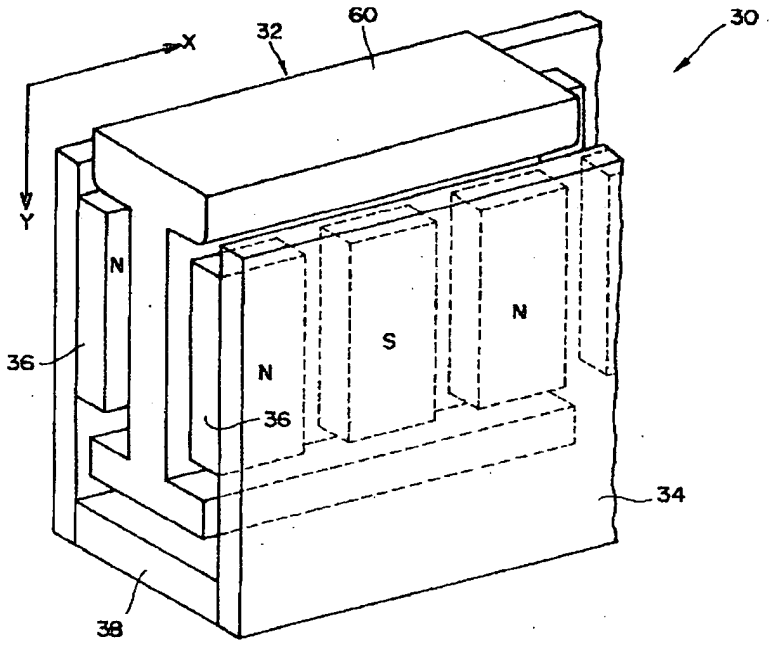
74,174 -- Branch passage
76,176 -- The 2nd mainstream way of an outside
78,178 -- Subpassage
74,174 -- Branch passage

DRAWINGS

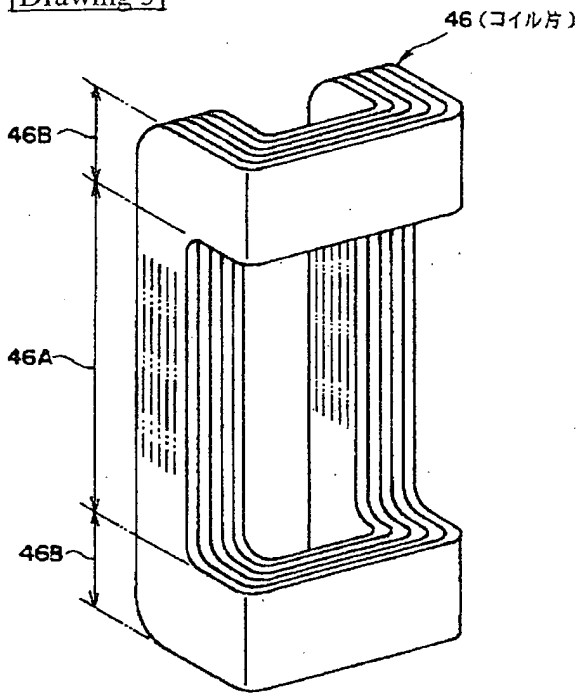
[Drawing 1]



[Drawing 2]



[Drawing 3]



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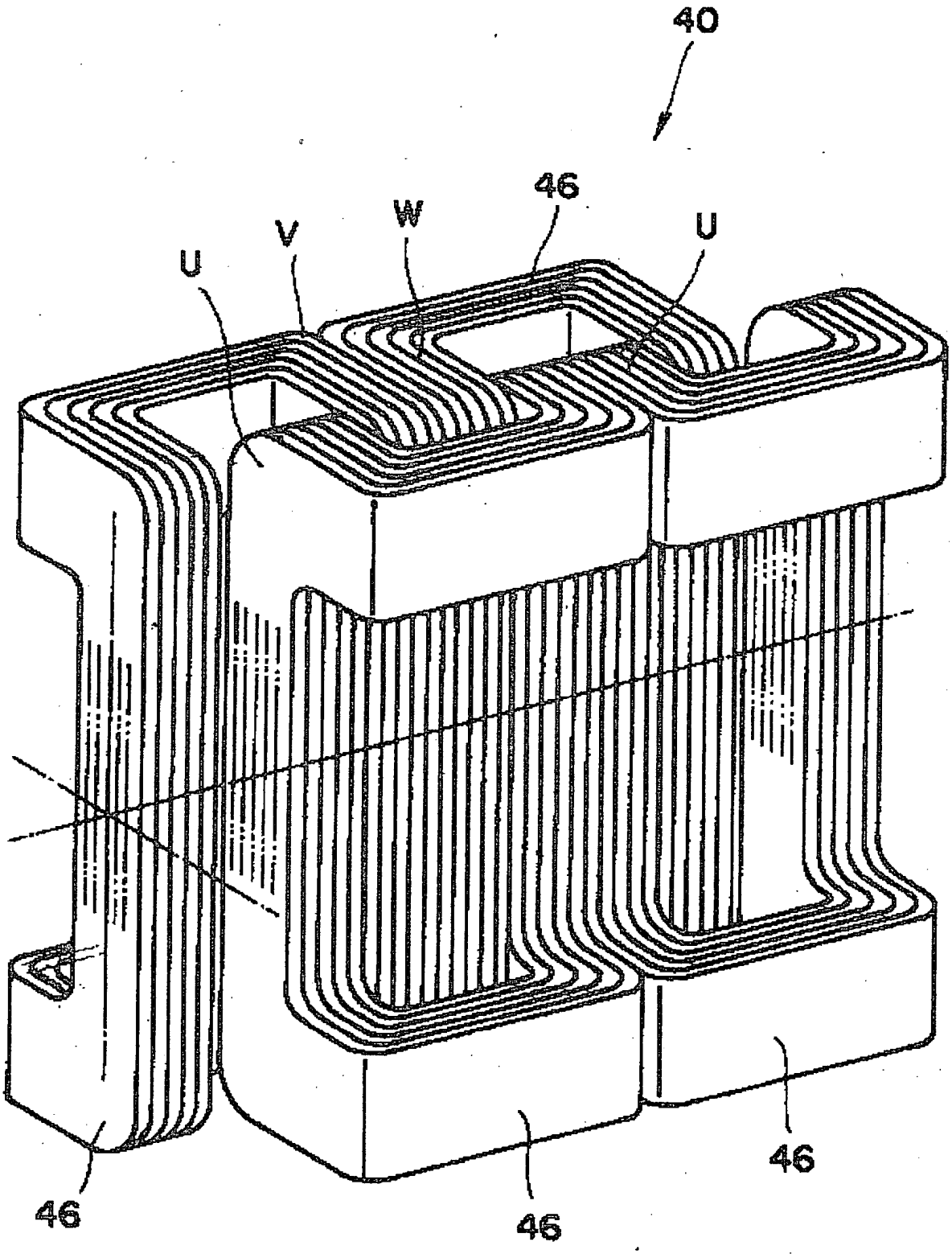
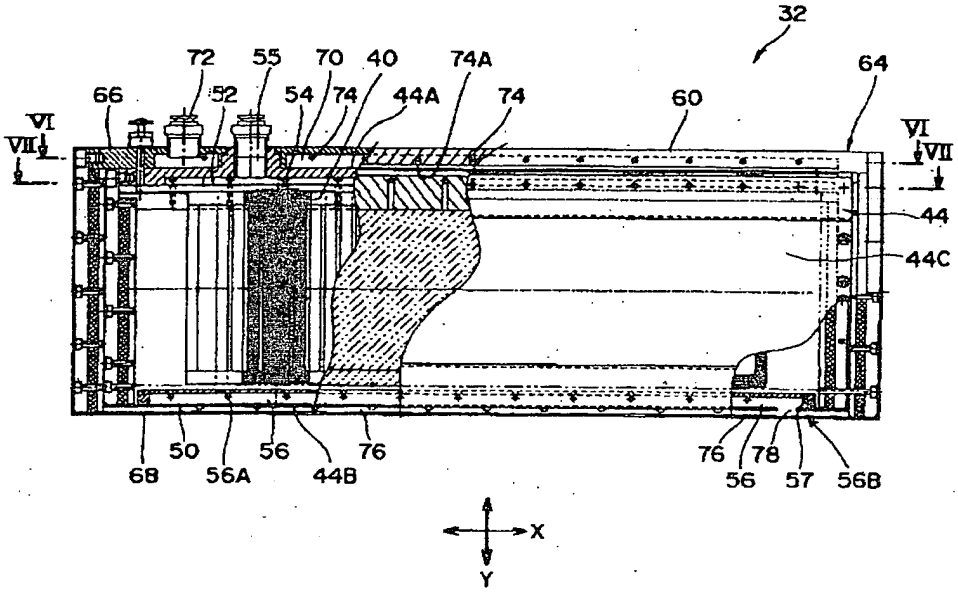


[Drawing 5]



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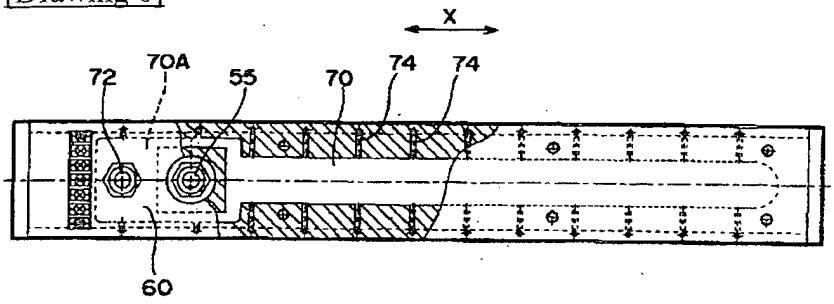

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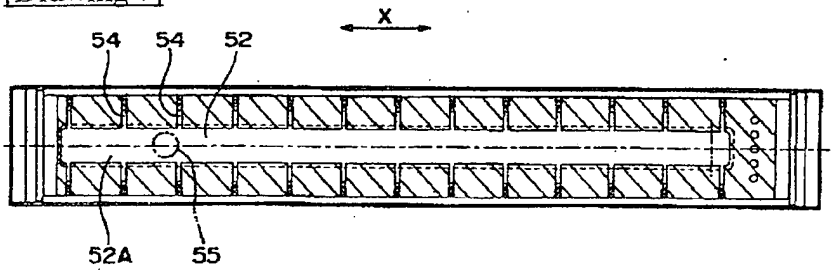
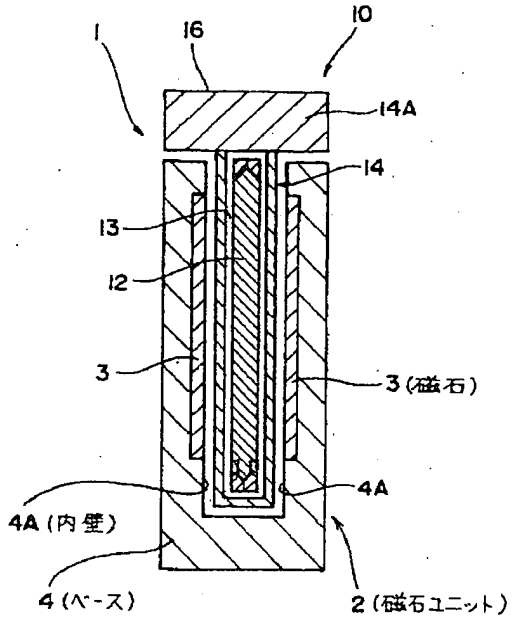


[Drawing 11]



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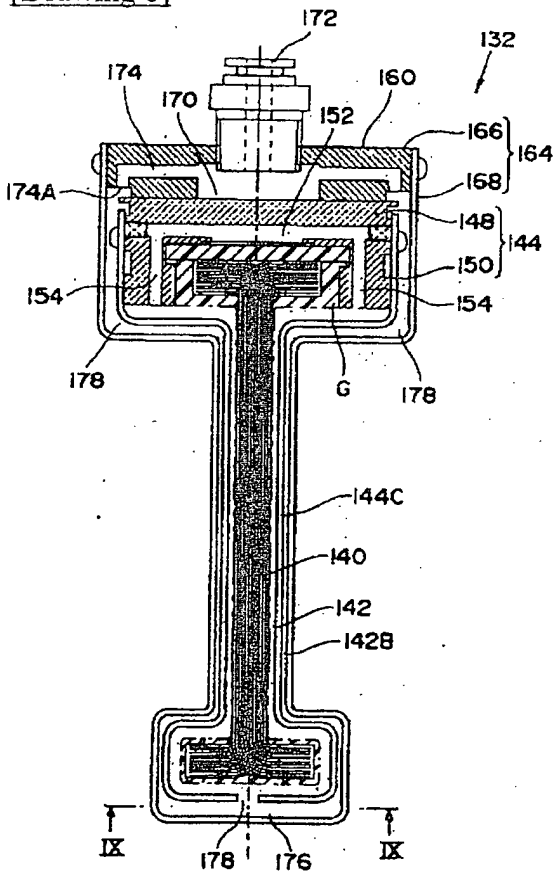

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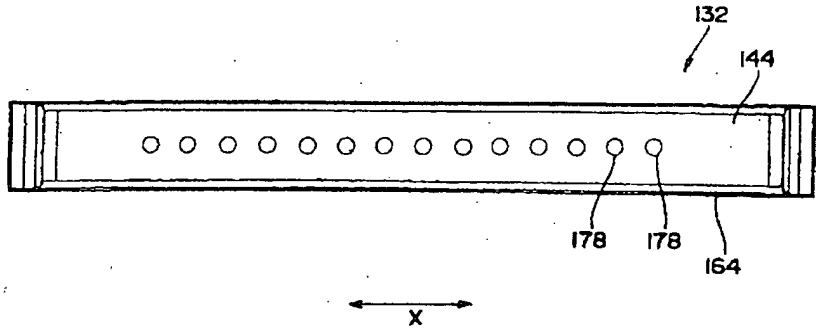

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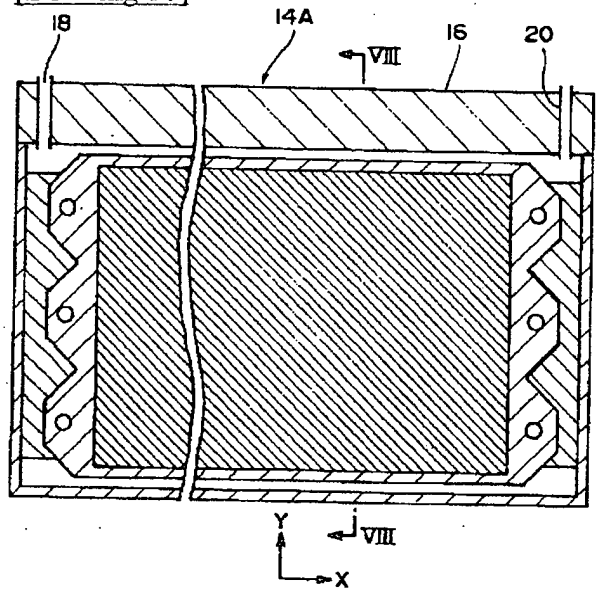
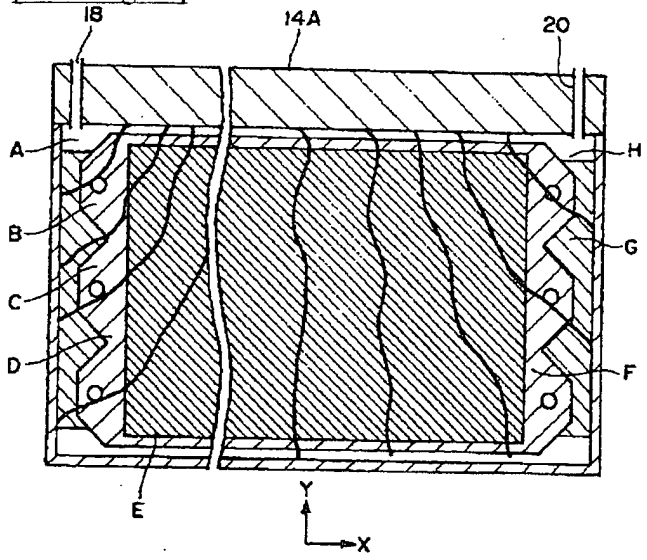


[Drawing 12]



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			Ａ	５Ｈ６０９
Ｐ２５Ｄ　1/00		Ｐ２５Ｄ　1/00	Ｂ	５Ｈ６４１
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9/19		9/19	Ｚ	

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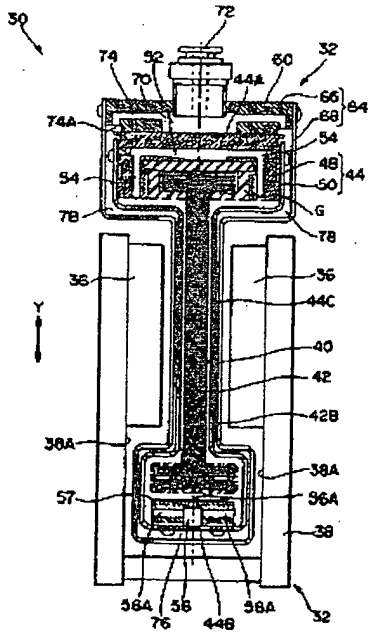
(54)【発明の名称】　リニアモータ用のコイルユニット

(57)【要約】
【課題】　コイルの発熱による相手機械及び周囲雰囲気への影響を低減させて、従来よりも高精度な位置決めを可能にする。
【解決手段】　コイル４０を内部に収容して、冷媒を通して冷却するシェル４４を備えたコイルユニット３２において、このシェル４４を内部に収容すると共に、隙間４２Ｂに冷媒を通してシェル４４を冷却可能な外側カバー６４を設置する。この外側カバー６４内のシェルの幅方向一端縁４４Ａ近傍には、冷媒を導入すると共に、シェル４４の外表面４４Ｃに導出可能な外側第１主流路７０を形成し、更に、外側カバー６４内のシェル４４の幅方向他端縁４４Ｂ近傍には、この外表面４４Ｃを流れてきた冷媒を受けると共に、シェル４４内に供給可能な外側第２主流路７６を形成する。コイル４０の表面を流れてきた冷媒を外部に排出可能な排出管を配置する。



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【特許請求の範囲】

【請求項１】リニアモータの磁石に対向配置されるコイルと、

該コイルを所定の隙間を空けて内部に収容すると共に、該隙間に冷媒を通して該コイルを冷却可能なシェルと、を備えたリニアモータに用いられるコイルユニットにおいて、

前記シェルを所定の隙間を空けて内部に収容すると共に、該隙間に冷媒を通して該シェルを冷却可能な外側カバーと、

該外側カバー内の前記シェルの幅方向一端縁近傍に長手方向に延びて形成され、外部から供給される前記冷媒を自身内に導入すると共に、該冷媒を該シェルの外表面に幅方向に導出可能な外側第１主流路と、

前記外側カバー内の前記シェルの幅方向他端縁近傍に長手方向に延びて形成され、前記外側第１主流路を経て前記シェルの外表面を幅方向に流れてきた前記冷媒を受けると共に、該冷媒を該シェル内に供給可能な外側第２主流路と、

シェル内のコイル表面を流れてきた前記冷媒を外部に排出可能な排出管と、

を備えることを特徴とするリニアモータ用のコイルユニット。

【請求項２】請求項１において、更に、

前記シェル内における前記外側第２主流路側に長手方向に延びて形成され、該外側第２主流路から供給される前記冷媒を自身内に導入すると共に、該冷媒を前記シェル内のコイルの表面に幅方向に導出可能な内側主流路を備えることを特徴とするリニアモータ用のコイルユニット。

【請求項３】請求項１又は２において、更に、

前記シェル内における前記外側第１主流路側に長手方向に延びて形成され、前記シェル内の該コイル表面を幅方向に流れてきた前記冷媒を受けると共に、該冷媒を前記排出管から排出可能な内側第２主流路を備えることを特徴とするリニアモータ用のコイルユニット。

【請求項４】請求項１、２又は３において、

前記外側カバーの長手方向一端側近傍に、前記外側第１主流路に前記冷媒を供給可能な供給孔を形成すると共に、前記外側第２主流路の長手方向他端側近傍に、自身内に案内された前記冷媒を前記シェル内に供給可能な連通孔を形成し、且つ該シェル内における前記供給孔近傍相当位置に、前記冷媒を排出可能な前記排出管を配置したことを特徴とするリニアモータ用のコイルユニット。

【請求項５】請求項４において、

前記排出管が、前記外側第１主流路における前記供給孔の下流側近傍を貫通するようにして配設されていることを特徴とするリニアモータ用のコイルユニット。

【請求項６】請求項１乃至５のいずれかにおいて、

前記外側第１主流路に、複数の枝流路を長手方向所定間隔で形成し、

該外側第１主流路内に導入された前記冷媒を該複数の枝流路の各々によって分岐させて、前記シェルの外表面に幅方向に導出可能にしたことを特徴とするリニアモータ用のコイルユニット。

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【請求項７】請求項６において、

前記枝流路の下流端に、該枝流路から導出される前記冷媒を一旦貯留可能な長手方向の副流路を形成し、該副流路を介して該冷媒を前記シェルの外表面に幅方向に導出可能にしたことを特徴とするリニアモータ用のコイルユニット。

【請求項８】リニアモータの磁石に対向配置されるコイルと、

該コイルを所定の隙間を空けて内部に収容すると共に、該隙間に冷媒を通して該コイルを冷却可能なシェルと、を備えたリニアモータに用いられるコイルユニットにおいて、

前記シェルを所定の隙間を空けて内部に収容すると共に、該隙間に冷媒を通して該シェルを冷却可能な外側カバーと、

前記シェル内の前記コイルの幅方向一端縁近傍に長手方向に延びて形成され、外部から供給される前記冷媒を自身内に導入すると共に該冷媒を前記コイルの表面に幅方向に導出可能な第１案内路と、

前記シェル内の前記コイルの幅方向他端縁近傍に長手方向に延びて形成され、前記第１案内路を経て該コイルの表面を幅方向に流れてきた前記冷媒を受けると共に、該冷媒を、該シェルと前記外側カバーとの前記隙間に供給可能な第２案内路と、

前記シェルの外表面を流れてきた前記冷媒を外部に排出可能な排出孔と、

を備えることを特徴とするリニアモータ用のコイルユニット。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、リニアモータにおける磁石に対向配置されるコイルと、このコイルを内部に収容して自身との隙間に冷媒を通して該コイルを冷却するシェルと、を備えたリニアモータ用のコイルユニットに関するものであり、特に、冷媒によってコイルを冷却する技術に関する。

【０００２】

【従来の技術】従来、例えば半導体製造用の露光装置や高精度加工機等においては、対象物（例えば露光されるウェハや被加工物）を高精度で且つ迅速に位置決めすることが要求されている。この際に利用される精密位置決め装置としては、回転型モータの回転をボールねじ等によって直線運動に変換するものや、直線運動型のモータ（いわゆるリニアモータ）等が広く利用されている。

【０００３】この中でもリニアモータは、構造が簡単で

部品点数が少なく済み、更にその直線運動を直接利用できるというメリットを有しており、対象物を迅速に位置決めすることができるものである。又、駆動時の摩擦抵抗が少ないために、動作精度を高めることができるという特徴も有している。以上の理由からリニアモータは、精密な位置決めが要求されるあらゆる分野の直線駆動装置として主流となりつつあり、例えば、液晶表示装置の製造工程等でも広く利用されている。

【０００４】このリニアモータは、一般的に、磁石を備えている磁極ユニットと、コイルを備えているコイルユニットとから構成される。磁極ユニットとコイルユニットのいずれか一方は所定の基台に連結されて固定子として機能し、他方は移動テーブル等に連結されて可動子として機能する。この磁極ユニットとコイルユニットとは互いに接触しないように一定の隙間が空けられており、その隙間を維持した状態で相対的に直線運動する。

【０００５】ところで、上記のコイルユニットに設けられるコイルは、電流が供給されると発熱する。この発熱はコイルユニット全体に伝達し、更に、このコイルユニットと結合している基台や移動テーブル等にまで伝達される。この結果、以下に示すような２つの問題が発生する。

【０００６】（１）コイルの熱によってコイルユニット自身や、このコイルユニットに連結される相手側機械が熱膨張して位置決め精度に誤差を生じさせる要因になる。具体的には、コイルユニットに連結される相手側機械が、例えば長さ１００ｍｍの低熱膨張材（熱膨張係数１×１０-6）であったとすれば、１℃の温度上昇によって１００ｎｍの熱変形が生じる。従って、ナノメートルオーダの位置決め精度が要求される場合には、この熱膨張が原因となって要求を十分に満たすことができない。

【０００７】（２）リニアモータの近傍には、このリニアモータの運動を計測するレーザ干渉計等が設置される。コイルユニットによって周囲の雰囲気が加熱されて「揺らぎ」が発生すると、レーザ光の光路に影響を与えて計測誤差が生じる。

【０００８】ここで、（１）の問題を解決するものとして、コイルユニットにおける相手側機械の取付面と、コイルとの間に冷媒を流して、コイルからの熱の伝達を防止する技術が知られている。しかし、この技術においてはコイルユニットの周囲の雰囲気の温度上昇を抑制することができず、結局（２）の問題点が解決されていなかった。

【０００９】そこで、（１）、（２）の双方の問題をまとめて解決するものとして、図１０、図１１に示されるようなコイルユニット１０が提案されている。このコイルユニット１０は、リニアモータ１に用いられるものであり、磁石ユニット２の磁石３に対向配置されている。

【００１０】具体的にこのコイルユニット１０は、磁石３に対向配置される進行方向Ｘに長い平板状のコイル１２と、このコイル１２を内部に収容すると共に、コイル１２と自身との隙間１３に冷媒を通してコイル１２を冷却可能なシェル１４と、を備える。一方、磁石ユニット２は、断面コ字状のベース４を備えており、このベース４内の対向する内壁４Ａに上記磁石３、３が取り付けられている。

【００１１】シェル１４における幅方向Ｙの一方の端縁１４Ａの外側には、相手側機械に対する取付面１６が形成されており、この取付面１６の長手方向Ｘの一端側には、シェル１４の隙間１３に冷媒を供給する供給孔１８が形成され、他端側にはこの冷媒を排出する排出孔２０が形成されている。この取付面１６を介してコイルユニット１０が「固定側の」相手側機械に連結された場合、コイルユニット１０が固定子となって磁石ユニット２が可動子となる。反対に、コイルユニット１０が「移動側の」相手機械に連結された場合、コイルユニット１０が可動子となって磁石ユニット２が固定子となる。

【００１２】供給孔１８から供給された冷媒は、コイル１２とシェル１４との隙間１３に拡散していき、コイル１２との間で熱を授受する。従って、電流によって発熱するコイル１２は冷却され、冷媒は加熱される。加熱された冷媒は排出孔２０から排出されるので、コイルユニット１０の内部に熱が蓄積されず、周囲の雰囲気への輻射が低減される。従って、このリニアモータ１はコイル１２の発熱による外部への影響を少なくすることができ、より高精度な位置決めが可能となっている。

【００１３】

【発明が解決しようとする課題】しかしながら、このようなコイルユニット１０においても、必ずしも十分な冷却効果が得られているとは言えなかった。具体的にシェル１４内の冷媒の拡散状況を図１２に模式的に示すと、冷媒はＡ、Ｂ、Ｃ・・・と徐々に広がりながら平行流となり、最後にＦ、Ｇ、Ｈと収束しながら排出孔２０から排出される。冷媒は下流側に移動するに従って加熱されていくので、このＡ、Ｂ、Ｃ・・・Ｅ、Ｇ、Ｈの順とほぼ一致するようにして温度が上昇していくことになる。

【００１４】この結果、特に下流側（Ｅ、Ｇ、Ｈ）近辺における冷媒の温度は上流側と比較して大幅に上昇しており、冷却効率が低下すると共にこの高温状態の冷媒を介してシェル１４に熱が伝達して外部に輻射されるという問題があった。更に、下流側の高温状態の冷媒を介して取付面１６に熱が伝達し、相手機械側の熱膨張を誘発する原因にもなっていた。

【００１５】しかもこの特性は冷媒の圧力（供給圧）と隙間の大きさが比較的良好に設計されていても不可避的に発生するものである。又、設計が良好でないときは、冷媒がほとんど流れない部分が生じ易いのが享情であり、不具合が一層顕著になることもあった。

【００１６】これらを解決するためには、冷媒の流量を増大して冷却効率を高める必要があるが、流量増大のた

めに隙間１３を大きくとると、磁石ユニット２側の磁石３．３間距離Ｓ（図１参照）が広くなって磁束密度が小さくなり、リニアモータ１の駆動力が低減するという問題があった。又．冷媒の流量を増大させると、シェル１４の肉厚を厚くして耐圧性を高める必要があり．この肉厚増大もリニアモータ１の駆動力（推力）の低下に影響を与えた。

【００１７】一方、近年の製造プロセスの高度化に伴い．リニアモータの温度上昇を更に高いレベルで抑制したいという要求が高まっている。しかしながら．シェル１４の厚みや隙間１３の大きさ等に一定の制約が課されている状況では．コイルユニット１０におけるコイル１２の冷却能力には限界があり、上記の要求を満足できないのが現状である。

【００１８】本発明は、上記に示したような冷媒によるコイルの不均一な冷却や．冷却能力不足に関連する問題点に鑑みてなされたものであり、冷媒を用いた新たな冷却構造によって．コイルユニットの温度上昇を従来よりも飛躍的に低減させることを目的とする。

【００１９】

【課題を解決するための手段】本発明は、リニアモータの磁石に対向配置されるコイルと、このコイルを所定の隙間を空けて内部に収容すると共に．該隙間に冷媒を通して該コイルを冷却可能なシェルと．を備えたリニアモータに用いられるコイルユニットにおいて、シェルを所定の隙間を空けて内部に収容すると共に、該隙間に冷媒を通してシェルを冷却可能な外側カバーと、この外側カバー内のシェルの幅方向一端縁近傍に長手方向に延びて形成され、外部から供給される冷媒を自身内に導入すると共に、この冷媒をシェルの外表面に幅方向に導出可能な外側第１主流路と、外側カバー内のシェルの幅方向他端縁近傍に長手方向に延びて形成され．外側第１主流路を経てシェルの外表面を幅方向に流れてきた冷媒を受けると共に、この冷媒をシェル内に供給可能な外側第２主流路と、シェル内のコイル表面を流れてきた冷媒を外部に排出可能な排出管と、を備えることにより、上記目的を達成するものである。

【００２０】このコイルユニットにおいては、シェルの周囲に更に外側カバーを配設することによる２重の冷却構造を採用した。又更に．外側第１主流路によって先ず（低温状態の）冷媒がコイルの長手方向に案内され、この外側第１主流路を経てシェルと外側カバーとの隙間を幅方向に（一端側から他端側に向けて）冷媒が流れる構造になっている。この冷媒は外側第２主流路を経てシェル内部に供給されて、コイル表面を幅方向に（他端側から一端側にむけて）に流れて（最も高温になった状態で）排出管から排出される。

【００２１】従って、長手方向に冷却の均一化が達成されることに加えて、コイル表面及びシェル外表面をいわゆる対向流によって冷却する構造であるので幅方向の均一化も図られ．コイルユニット全体に亘って温度が均一となりやすく．又冷却効率も従来より大幅に高められている。その結果．周囲の雰囲気の局所的な温度上昇が防止される。

【００２２】又．外側カバー内に供給された最も低温状態の冷媒によって、シェル内の排出される直前の最も高温状態の冷媒が覆われる。又、幅方向中間近傍では、外側カバー内を流れる過度に低温状態の冷媒によって、シェル内の（コイルを冷却して）過度に高温状態になった冷媒が覆われる。このようにして、外側カバー内の冷媒の存在により．内から外へコイルの熱伝達が極めて合理的に抑制されるので、従来よりも大幅にコイルユニットの温度上昇を低減する事が出来る。

【００２３】なお、上記発明においては、更に．シェル内における外側第２主流路側に長手方向に延びて形成され．外側第２主流路から供給される前記冷媒を自身内に導入すると共に．冷媒を前記シェル内のコイルの表面に幅方向に導出可能な内側主流路を備えるようにしてもよい。

【００２４】この構造によれば、外側第２主流路まで流れてきたことによって冷媒の流れが不均一になった（乱れた）場合であっても、内側主流路によって冷媒が長手方向に再び導入されてからコイル表面に導出されるので．コイルの均一な冷却が可能になる。

【００２５】上記発明では更に、シェル内における外側第１主流路側に長手方向に延びて形成され、シェル内のコイル表面を幅方向に流れてきた冷媒を受けると共に、この冷媒を排出管から排出可能な内側第２主流路を備えるようにしてもよい。

【００２６】コイルを冷却することで高温となった冷媒は．出来るだけ速やかに外部に排出して周囲への熱の影響を抑制しなければならない。そこで本構造によれば、高温状態の冷媒はまず内側第２主流路に速やかに排出されてコイル周囲に滞らないので、コイル上の局所的な高温状態が防止される。

【００２７】更に、この（高温状態の）冷媒が導入される長手方向の内側第２主流路を、最も低温状態の冷媒が導入される長手方向の外側第１主流路によって覆うことができるので．周囲雰囲気や機械取付面への熱伝達が抑制される。なお．上記内容から明らかなように．このコイルユニットを相手側機械に取り付ける機械取付面は、外側カバーの外周における外側第１主流路側が好ましい。これは、該外側第１主流路によってコイルからの熱伝達が遮断されるからである。

【００２８】又．上記の発明においては、外カバーの長手方向一端側近傍に、外側第１主流路に冷媒を供給可能な供給孔を形成すると共に．外側第２主流路の長手方向他端側近傍に．自身内に案内された冷媒をシェル内に供給可能な連通孔を形成し．且つシェル内における前記供給孔近傍相当位置に、該シェル内の冷媒を排出可能な排

出管を配置することが好ましい。

【００２９】このようにすると、供給孔→連通孔→排出管の順番に冷媒が移動するので、全体視すると、供給孔から冷媒が供給されてコイルユニットの対角線上を移動し、再び供給孔近傍まで戻ってきて排出管から排出されるような冷却構造になる。従って、コイル全体に亘って更に均一な冷却効果を得ることが出来、周囲の雰囲気の温度上昇を更に高いレベルで抑制可能となる。又、供給側と排出側が近接するので外部の配管設計が容易になる。

【００３０】更に上記排出管を、外側第１主流路における供給孔の下流側近傍を貫通するようにして配設する事が好ましく、このようにすると、最も高温状態の冷媒が通過する排出管の外周面が、外側第１主流路を流れる冷媒によって冷却されるので、排出管近傍のコイルユニットの局所的な温度上昇を抑制しながら、即ち、排出管内の冷媒のみが温まった状態でコイルの発生する熱を回収することが出来る。なお、供給孔の下流側近傍とは、供給孔よりも長手方向内側に位置し且つ該供給孔に近いことと略同義である。

【００３１】又、上記の総ての発明における外側第１主流路が、冷媒をシェルの外表面に幅方向に導出する手段としては、例えば、外側第１主流路に複数の枝流路を長手方向所定間隔で形成し、この外側第１主流路内に導入された冷媒をこの複数の枝流路の各々によって分岐させて、シェルの外表面に幅方向に導出可能にすることが望ましい。なお、この枝流路の数、形状、長さ等は何等限定されるものではなく、要は、冷媒を幅方向に導出可能なものであれば良い。

【００３２】更にこの枝流路の下流端には、該枝流路から導出される前記冷媒を一旦貯留可能な長手方向の副流路を形成し、副流路を介して該冷媒を前記シェルの外表面に導出可能とする事が好ましい。この構造によれば、各枝流路から導出された冷媒が副流路によって長手方向に拡散し、圧力や流量が長手方向に平均化されながらシェルの外表面に導出されるので、コイルユニットの外周面の温度分布の均一性を高めることが出来る。又、枝流路によって１又は、副流路によって、第１主流路における冷媒の圧力が長手方向に拡散されて幅方向に流れ込むので、外カバーやシェルの内厚を薄くすることも可能であり、二重冷却構造にしたとしても、コイルユニットを比較的コンパクトに構成することが出来る。

【００３３】ところで、上記のような思想は、コイルユニットが周囲の雰囲気及び相手機械に与える熱影響を抑制することを主な目的としているが、一方で、冷媒を反対方向に流せばコイルユニットの「放熱性」をより高めた使い方が出来るようになる。

【００３４】具体的には、リニアモータの磁石に対向配置されるコイルと、コイルを所定の隙間を空けて内部に収容すると共に、隙間に冷媒を通して該コイルを冷却可能なシェルと、を備えたリニアモータに用いられるコイルユニットにおいて、シェルを所定の隙間を空けて内部に収容すると共に、該隙間に冷媒を通して該シェルを冷却可能な外側カバーと、シェル内のコイルの幅方向一端縁近傍に長手方向に延びて形成され、外部から供給される冷媒を自身内に導入すると共にこの冷媒をコイルの表面に幅方向に導出可能な第１案内路と、シェル内のコイルの幅方向他端縁近傍に長手方向に延びて形成され、第１案内路を経てコイルの表面を幅方向に流れてきた冷媒を受けると共に、この冷媒を、シェルと外側カバーとの隙間に供給可能な第２案内路と、シェル外表面を流れてきた冷媒を外部に排出可能な排出孔と、を備えるようにすればよい。

【００３５】この発明は、要は、これまで説明してきた構造の冷媒の流れ（上流、下流）を逆に考えたものである。

【００３６】このようにすれば、低温状態の冷媒がまずコイル表面を冷却し、その後シェルと外側カバーとの隙間を流れることで、冷媒の熱が外部に放出される。従って、コイルを積極的に冷却することが出来るので、特に、大容量のリニアモータにおいて（周囲の雰囲気の温度上昇の抑制よりも）コイルの温度上昇自体を極力低減させる必要がある場合に適している。なお、更に詳細な構造も上記に示したものを総て反対に応用すればよい。

【００３７】

【発明の実施の形態】以下、図面を参照しながら本発明の実施の形態について詳細に説明する。

【００３８】図１及び図２には、第１実施形態に係るリニアモータ３０に用いられるコイルユニット３２が示されている。

【００３９】コイルユニット３２は、磁石ユニット３４の磁石３６、３６に対向配置される進行方向Ｘ（図２参照）に長い平板状のコイル４０と、このコイル４０を所定の隙間４２を空けて内部に収容すると共に、この隙間４２に冷媒を通してコイル４０を冷却可能なシェル４４と、このシェル４４を所定の隙間４２Ｂを明けて内部に収容するとともに、この隙間４２Ｂに冷媒を通してシェル４４を冷却可能な外側カバー６４と、を備える。なお、この磁石ユニット３４は、断面コ字状のベース３８を備えており、このベース３８の内壁３８Ａに上記磁石３６、３６が取り付けられた構造である。

【００４０】平板状のコイル４０は、進行方向Ｘに垂直な断面がＩ字状（鞍型）になっており、より具体的には、図３に示されるコイル片４６が複数組み合わせされて構成される。このコイル片４６は、銅線をリング状に巻いたものであるが、全体として（外観上は）直線部４６Ａと、この直線部４６Ａの両端に屈曲形成される屈曲部４６Ｂと、を備えるように整形される。従って図４に示されるように、複数のコイル片４６を直線部４６Ａが重なり合うように交互に組み合わせ、進行方向Ｘの順番

にU層、V層、W層・・・とすれば、断面が１字状の上記コイル４０が構成される。このままの状態では互いに連結されておらず分解してしまうので、図２に示されるように、このコイル４０は、幅方向Ｙ一端縁４０Ａ側に配置される長手方向のコイルホルダ４８と共に樹脂Ｇによって一体モールドされている。

【００４１】シェル４４は、コイル４０を内部に収容する部材であり、上記のコイルホルダ４８と、このコイルホルダ４８に連結されるステンレス製のプレート５０と、を備える。プレート５０は、コイル４０の断面１字状に沿うようにして屈曲されており、内部にコイル４０を収容した状態で該コイル４０の直線部４６Ａに所定の隙間４２が形成されるようになっている。

【００４２】外側カバー６４は、シェル４４を内部に収容する部材であり、コイルホルダ４８の幅方向Ｙ外側に取り付けられる進行方向Ｘに長い外蓋６６と、この外蓋６６に連結されるステンレス製の外側プレート６８と、を備えて構成される。外側プレート６８は、シェル４４のプレート５０に沿うようにして屈曲されており、内部にシェル４４を収容した状態で（コイル４０の直線部４６Ａ相当位置に）所定の隙間４２Ｂが形成されるようになっている。

【００４３】次に、図１及び図５～図７を参照して、コイルユニット３２におけるコイル４０の冷却構造について詳細に説明する。

【００４４】図５及び図６に示されるように、外側カバー６４内におけるシェル４４の幅方向一端縁４４Ａ近傍には、長手方向（進行方向と同じ）Ｘに延びる外側第１主流路７０が形成されている。この外側第１主流路７０の長手方向一端７０Ａ側近傍には、この外側第１主流路７０に冷媒を供給可能な供給孔７２が形成されており、この供給孔７２から供給される冷媒が外側第１主流路７０によって長手方向Ｘに案内される。

【００４５】この外側第１主流路７０には、複数の枝流路７４が長手方向Ｘ所定間隔で形成される。この枝流路７４によって外側第１主流路７０内に導入された冷媒が分岐されて、シェル４４の外表面（隙間４２Ｂ）を幅方向Ｙに流れていく。

【００４６】外側カバー６４内におけるシェル４４の幅方向他端縁４４Ｂ側近傍には、長手方向Ｘに延びる外側第２主流路７６が形成されている。この外側第２主流流路７６は、外側第１主流路７０及び枝流路７４を経てシェル４４の外表面４４Ｃ（隙間４２Ｂ）を幅方向Ｙに流れてきた冷媒を受けると共に、この冷媒をシェル４４の内部に供給するようになっている。なお、この外側第２主流路７６は、プレート５０と外側プレート６８との隙間を（コイル４０の直線部４０Ａ近傍の隙間４２Ｂよりも）拡張することによって形成されている。

【００４７】上記枝流路７４の下流端７４Ａ（図１参照）には、ここから導出される冷媒を一旦貯留可能な長手方向Ｘの副流路７８が形成されている。この副流路７８は冷媒を貯留すると共にこの冷媒を隙間４２Ｂに導出する構造になっており、いわゆるバッファ的な役割を有している。なお、この副流路７８は、プレート５０と外側プレート６８との隙間を上記隙間４２Ｂよりも拡張することによって形成されている。

【００４８】なお、上記外側第１主流路７０及び枝流路７４は、外蓋６６の内壁に切削等によって溝を形成し、この外蓋６６をコイルホルダ４８に取り付けた状態の前記溝で構成されるようにすればよい。

【００４９】次に、シェル４４の内部の冷却構造について説明する。

【００５０】図５に示されるように、シェル４４の内部には、外側第２主流路７６側に長手方向Ｘに延びる内側主流路５６が形成されている。つまり、外側第２主流路７６と内側主流路５６は平行に配置される。この外側第２主流路７６と内側主流路５６の長手方向Ｘ他端側５６Ｂ（即ち、長手方向Ｘにおける供給孔７２と反対側）にはこれらを連結する連通孔７８が形成されており、この連通孔７８を介して、外側第２主流路７６を案内された冷媒が内側主流路５６に供給される。なお、この内側主流路５６は、シェル４４内に配置された長手方向Ｘの流路形成部材５７に溝を形成することによって構成されている。

【００５１】この内側主流路５６には、長手方向Ｘに所定間隔で複数の内側枝流路５６Ａが形成されており、内側主流路５６内を長手方向Ｘに案内された冷媒が、この内側枝流路５６Ａを介してコイル４０の表面に（隙間４２に）幅方向Ｙに導出されるようになっている。詳細には、この枝流路５６Ａは、所定間隔毎にそれぞれ３方向に形成されており（図１参照）、それぞれから導出された冷媒が隙間４２側に流れていく。

【００５２】シェル４４内における外側第１主流路７０側には、図７に示されるように、コイル４０の表面を幅方向Ｙに流れてきた冷媒を受ける内側第２主流路５２が形成されている。この内側第２主流路５２には長手方向Ｘ所定間隔で細孔５４が形成されており（図１参照）、コイル４０の表面を流れてきた冷媒は複数の細孔５４を介して内側第２主流路５２に流れ込む。更に、この内側第２主流路５２における長手方向Ｘの一端５２Ａ側には、この内側第２主流路５２によって回収された冷媒を排出可能な排出管５５が形成されている。より具体的には、外側第１主流路７０における供給孔７２の下流側近傍を、上記排出管５５が貫通して外蓋６６側に開口するようになっている。つまり、排出管５５の周囲を外側第１主流路７０が取り囲むようになっている（図６参照）。

【００５３】なお、内側第２主流路５２及び細孔５４等は、コイル４０を一体モールドする以前のコイルホルダ４８に切削等によって形成しておけばよい。

【００５４】次に、このコイルユニット３２の作用について説明する。

【００５５】供給孔７２から供給された冷媒は、外側第１主流路７０によって長手方向Ｘに案内される。この外側第１主流路７０の圧力が高まると、冷媒は枝流路７４を介して副流路７８に流れ出す。各枝流路７４から副流路７８に導入される冷媒量は、外側第１主流路７０の機能により既に長手方向Ｘにおいてかなり均一化されているため、副流路７８内の冷媒の圧力はその長手方向Ｘにおいて一層均一化される。そしてこの副流路７８内の冷媒が隙間４２Ｂに幅方向Ｙに流れ込む。

【００５６】この隙間４２Ｂを経てシェル４４の外表面４４Ｃを冷却した冷媒は外側第２主流路７６に流れ込み、長手方向Ｘに案内される。この冷媒は連通孔７８から内側主流路５６に供給され、上記の外側第２主流路７６の案内方向と反対方向に案内される。この内側主流路５６における冷媒の圧力が高まると、この冷媒が内側枝流路５６Ａから流れだし、シェル４４の内部を満たしていく。幅方向Ｙに沿って流れてコイル４０を冷却した冷媒は、細孔５４を経て内側第２主流路５２内に流れ込む。この内側第２主流路５２内に流れ込んだ冷媒は長手方向Ｘに案内されて排出管５５から排出される。

【００５７】このコイルユニット３２によれば、コイル４０をシェル４４及び外側カバー６４によって覆う二重構造になっている。更に、外側第１主流路７０及び内側主流路５６によって冷媒が長手方向Ｘに案内（拡散）されると共に、その後に幅方向Ｙに流れ出す構造である。従って、各隙間４２、４２Ｂにおいて相対的に幅方向Ｙの対向流が形成される。

【００５８】これらの冷媒の長手方向Ｘの拡散及び幅方向Ｙ対向流により、長手方向Ｘ及び幅方向Ｙの双方向において均一な冷却が達成されるので、コイルユニット３２の全体に亘って温度を均一にすることができる。その結果、冷媒の流量を増大させなくても、従来と比較して大幅に冷却効率を高めることができる。

【００５９】例えば、本発明者による解析結果によれば、仮にコイルの発熱量を２００（Ｗ）、冷媒の流量を２（ｌ／ｍｉｎ）とした場合には、従来のコイルユニットの外表面の温度が約２．５℃上昇するのに対して、本第１実施形態のコイルユニット３２では約０．４５℃の温度上昇に抑えられている。なお、シェルの材質や冷媒の種類によって上記解析結果は異なるものであるが、いずれの場合においても極めて優れた結果を得ることができる。

【００６０】特に、外側カバー６４とシェル４４との隙間４２Ｂを流れる冷媒は、コイル４０の外部への熱伝達の影響を効果的に遮断するものであり、シェル４４の最も高温となる部分を最も低温状態の冷媒で覆う構造になっている。つまり、外側の隙間４２Ｂに流れたばかりの低温の冷媒は、シェル４４内の回収直前の高温の冷媒を覆うことになるので、コイル４０の冷却効率の向上に加えて外部雰囲気への熱伝達量を大幅に低減することができる。

【００６１】又、隙間４２Ｂを幅方向Ｙに流れることによって冷媒の流れが乱れた場合でも、外側第２主流路７６によって回収されて再び内側主流路５６によって長手方向Ｘに案内されるので、コイル４０の表面の隙間４２においても長手方向Ｘに均一な流れを形成することができる。更に、コイル４０を冷却して高温状態となった冷媒は、細孔５４を介して内側第２主流路５２に速やかに回収されるので、コイル４４上における冷媒の澱みが防止されて局所的な高温状態を防止することができる。この観点から、上記細孔５４はできるだけ数多く形成することが好ましく、又、スリット状にして細孔５４の流路断面積を拡張するようにしてもよい。

【００６２】又、取付面６０とコイル４０との間には、（最も低温状態の冷媒が導入される）外側第１主流路７０が介在しているので、取付面６０への熱伝達量が抑制されて、相手機械側の熱膨張が大幅に低減される。

【００６３】更に、本第１実施形態においては、供給孔７２→連通孔７８→排出管５５の順番に冷媒が移動するので、全体的に考えると長手方向Ｘにも対向流が形成されている。特に、外側第１主流路７０と内側第２主流路５２、外側第２主流路７６と内側主流路５６との間には明らかに対向流が形成されており、このことによっても長手方向Ｘの均一な冷却が達成されている。又、供給孔７２と排出管５５とが近接するので、外部の配管設計が大変容易になる。

【００６４】排出管５５には最も高温状態の冷媒が通過することになるが、この排出管５４の周囲を第１主流路７０が取り囲んでいるので（図６参照）、この排出管５５からの取付面６０への熱伝達を低減することができ、このことによっても相手側機械の熱膨張が低減される。

【００６５】次に、図８、図９を参照して、本発明の第２実施形態に係るコイルユニット１３２について説明する。なお、以下に具体的に説明しない部分・部材等については、上記の第１実施形態に係るコイルユニット３２とほぼ同様であるので、同一部分にはこのコイルユニット３２と下２桁を同一符号を付することによって、構成、作用等の詳細な説明は省略する。

【００６６】このコイルユニット１３２における外側第２主流路１７６には、シェル１４４の内部に冷媒を供給する複数の連通孔１７８が長手方向Ｘに所定間隔で形成されている。この外側第２主流路１７６はこれらの連通孔１７８を介して隙間４２に直接冷媒を供給することができる。従って、第１実施形態のコイルユニット３２における内側主流路５６は形成されていない（外側第２主流路１７６が内側主流路の機能を兼ねているとも言える）。

【００６７】このコイルユニット１３２においても、外

側第１主流路１７０によって冷媒が長手方向Ｘに案内されると共に、枝流路１７４を経て幅方向Ｙに導出される。更に、外側第２主流路１７６においても複数の連通孔１７８を経て冷媒が幅方向Ｙに導出される。従って、長手方向Ｘの冷媒の拡散と幅方向Ｙの対向流によって、上記の第１実施形態とほぼ同等の効果を得ることができ、更に第１実施形態よりも内部構造を簡潔にすることができる。

【００６８】なお、上記の第１及び第２実施形態においては、枝流路７４や連通孔１７８が長手方向に等間隔で配置されている場合を示したが、本発明はそれに限定されない。又、枝流路７４や連通孔１７８の長さや形状についても特に制限はない。

【００６９】更に、本発明における冷媒を幅方向Ｙに流すという概念は、コイルユニットを全体的に見た場合を考慮に入れたものである。即ち、従来は長手方向に積極的に冷媒を流していたのに対して、本発明は幅方向に積極的に流すものであり、冷媒の幅方向の流れに多少のズレや殺みがあったとしても、本発明が想定している範囲内である。

【００７０】以上に示したコイルユニット３２、１３２は、コイル４０の外部への熱伝達の影響を防止することに主眼を置いているが、この構造において冷媒を反対に流せば（逆流させれば）コイルの温度上昇自体を極力低減させる放熱構造を得ることができる。

【００７１】具体的には、図５で示したコイルユニット３２において、排出管５５を供給管、内側第２主流路５２を第１案内路、内側主流路５６を第２案内路、供給孔７２を排出孔とすればよい。このようにすると、供給管（排出管５５）から供給される冷媒が第１案内路（内側第２主流路５２）によって長手方向Ｘに案内され、細孔５４を経てコイル４０の表面に冷媒が幅方向Ｙに導出される。コイル４０を冷却した冷媒は第２案内路（内側主流路５６）に受け止められて、シェル４４と外側カバー６４との隙間４２Ｂに導出される。外側カバー６４によって熱が効果的に外部に放出されることで、コイル４０を積極的に冷却した冷媒は、最終的に排出孔（供給孔７２）から排出されることになる。

【００７２】

【発明の効果】本発明に係るコイルユニットによれば、コイルの冷却効率を大幅に高めると共に、周囲の雰囲気及び相手機械に対する熱伝達を大幅に抑制することができる。従って、リニアモータによる相手機械の位置決め精度を高めることができる。

【図面の簡単な説明】

【図１】本発明の第１実施形態に係るコイルユニットが適用されるリニアモータを示す断面図

【図２】同リニアモータを部分的に示す斜視図

【図３】同コイルユニットに用いられるコイル片を示す斜視図

【図４】同コイル片を複数組み合わせて構成したコイルを示す斜視図

【図５】同コイルユニットの冷却構造を示す部分断面図

【図６】図５のVI－VI断面図

【図７】図５のVII－VII断面図

【図８】本発明の第２実施形態に係るコイルユニットを示す断面図

【図９】図８のIX－IX断面図

【図１０】従来のリニアモータを示す断面図

【図１１】図１０の11－11断面図

【図１２】同リニアモータのコイルユニットにおける冷媒の拡散状況を示す模式図

【符号の説明】

３０…リニアモータ

３２、１３２…コイルユニット

３４…磁石ユニット

３６…磁石

４２、４２Ｂ、１４２、１４２Ｂ…隙間

４４、１４４…シェル

４４Ａ、１４４Ａ…一端縁

４４Ｂ、１４４Ｂ…他端縁

５２、１５２…内側第２主流路

５４、１５４…細孔

５５、１５５…排出管

５６…内側主流路

６０、１６０…取付面

６４、１６４…外側カバー

６６、１６６…外盖

６８、１６８…外側プレート

７０、１７０…外側第１主流路

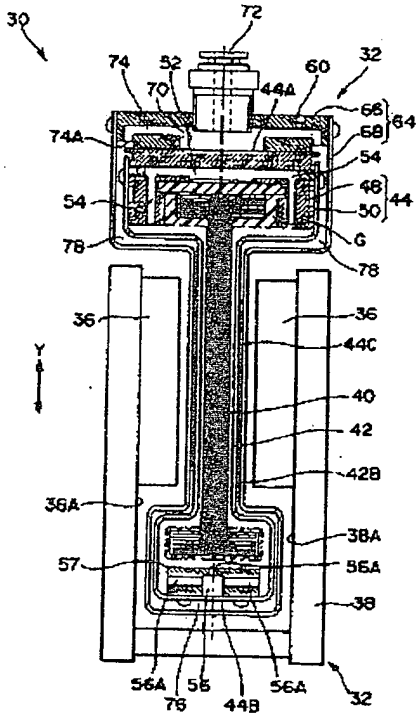
７４、１７４…枝流路

７６、１７６…外側第２主流路

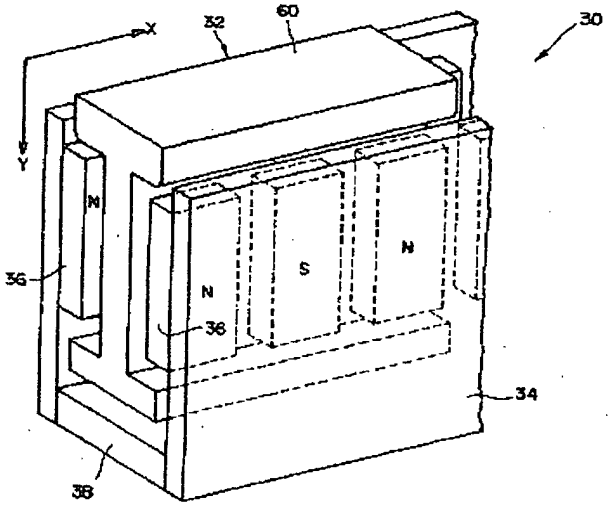
７８、１７８…副流路

７４、１７４…枝流路

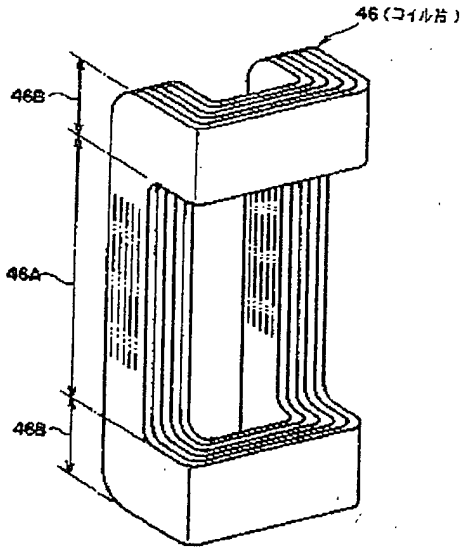
【図1】


30
72
74
52
70
60
32
44A
66
64
68
74A
54
46
44
50
54
G
78
78
36
36
44C
Y
40
42
42B
36A
38A
57
56A
38
56A
56
56A
78
44B
32

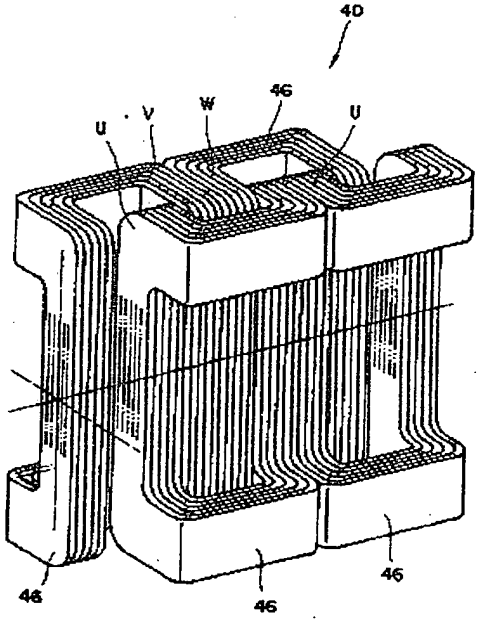
【図2】


X
32
60
30
Y
N
S
N
36
N
36
34
38

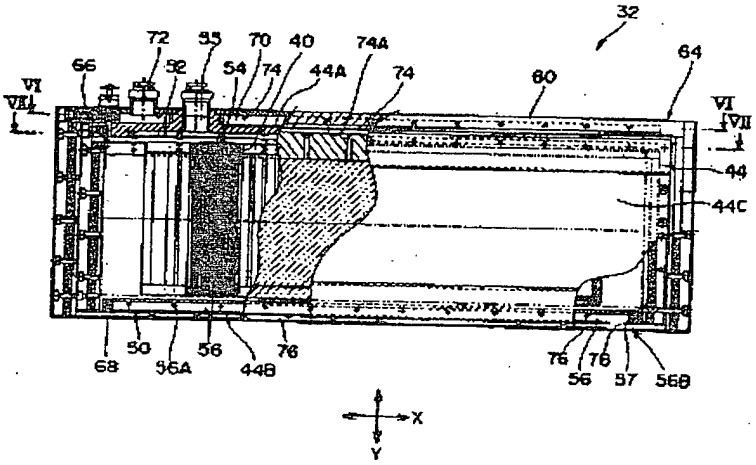
【図3】


46(コイル片)
46B
46A
46B

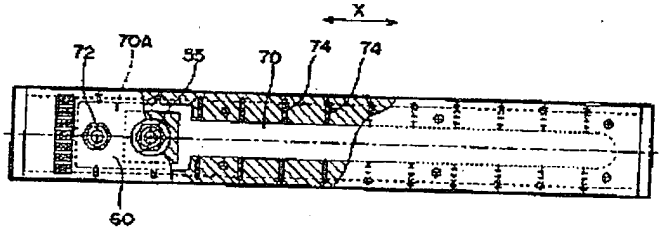
【図4】


40
U
V
W
46
U
46
46
46

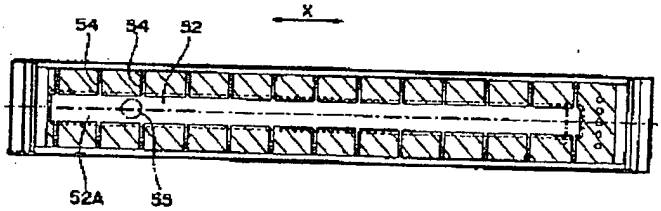
【図５】



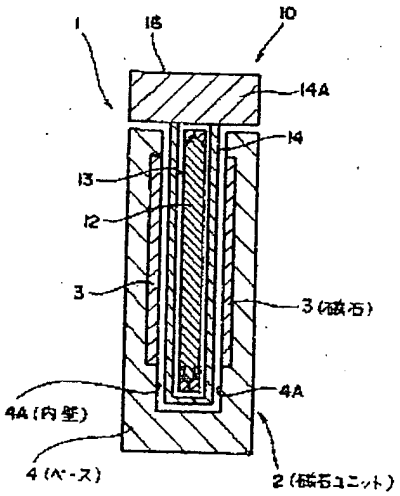
【図６】



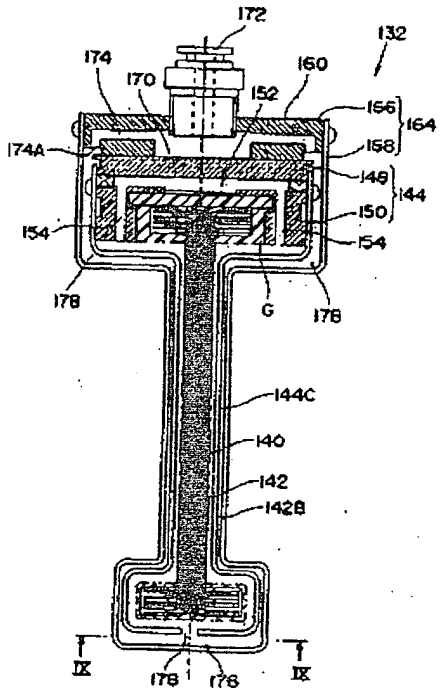
【図７】



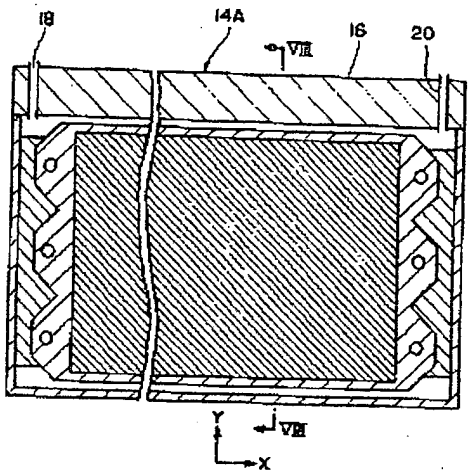
【図１１】



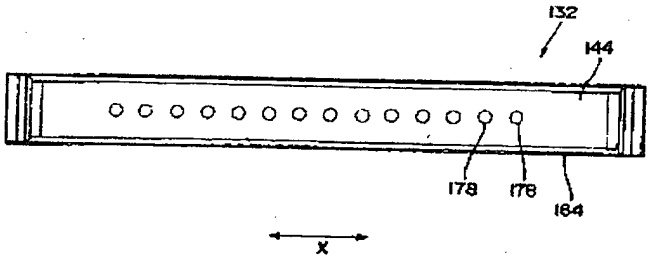
【図8】


172
132
174
170
160
152
156
164
174A
158
148
144
150
154
154
178
G
178
144C
140
142
142B
IX
178
178
IX

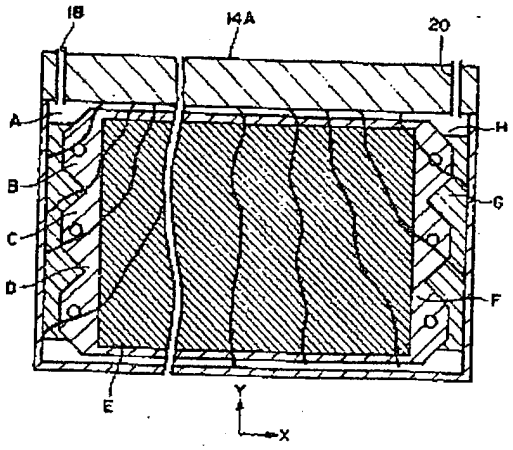
【図10】


18
14A
VIII
16
20
Y
VIII
X

【図9】


132
144
178
178
164
X

[図１２]



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PP09 QQ04 QQ05 QQ10 QQ14
QQ16 RR27 RR36 RR37 RR41
5H641 BB03 BB06 BB18 BB19 GG02
GG03 GG05 GG07 HH02 HH03
JB04